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ALESSANDRO VOLTA.

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HERBERT SPENCER AND THE SYNTHETIC PHILOSOPHY.*

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THE present paper aims at furnishing an introduction to the study of Mr. Spencer's philosophic system; but, to avoid all possibility of misconception, it may be well to state at the outset in what sense the word introduction is here employed. Let it be understood, then, that by it we mean neither an exposition nor a criticism; in other words, we do not now undertake either to summarize the arguments and conclusions of the Synthetic Philosophy, or to pass judgment upon them. Popular introductions to abstruse and voluminous works too often confine themselves to one or both of these methods; our course, on the other hand, will be a humbler, but, we may trust, not less useful one. Assuming that the student of any great epoch-making work will feel himself the better prepared to grapple with that work if he knows something of its genetic history—I mean, of its inception, formulation, and growth; and will be placed in a more advantageous position for judging of its essential merits if he understands its relation to the thought and speculation of the time, we purpose to approach Mr. Spencer's philosophy by way of its evolution; to consider, not what it is to-day, but rather how it came to be what it is to-day. In a brief outline of the gradual unfolding and consolidation of Mr. Spencer's thought, and in some appreciation of the historic significance of his writings, will, we believe, be found the best kind of introduction for those who would prepare themselves for the direct and personal study of his works.

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* Read before the Unity Club, Ithaca, New York.

In the first place, then, we have to review the growth and solidification of Mr. Spencer's thought—in other words, the elaboration, as exhibited in his earlier writings, of that conception of evolution which was to find its definite expression in the majestic series of works of which the Synthetic Philosophy is composed. Let us begin by making ourselves acquainted with the starting-point of his mental development—that is, with the general theory of things which was current during his early years, and under the influence of which, in common with all his contemporaries, he grew to man's estate.

The period of Spencer's youth and ripening manhood was a period of transition in scientific and philosophic thought. On the ushering in of the present century the old cosmology still held sway with unabated vigor, along with all those time-worn dogmas concerning human life and destiny which had grown up with it during ages of ignorance and superstition, and with which its own existence was now inextricably bound up. What that cosmology and what those dogmas meant is a matter of such common history that we need not linger over them here. Suffice it to say that the unquestioned doctrines of special creation, fixed types, and a recent origin of the universe, lay at the bottom of them all, and that it was in the light of those doctrines that the world and life and man were one and all interpreted.

But before the century had got far upon its way, signs began to manifest themselves of an approaching change in the higher regions of thought. The special-creation hypothesis and the postulate of the world's recent origin and rapid manufacture had served well enough so long as their field had remained uninvaded by the results of investigation—so long as they had not been confronted with definite facts. In perfect keeping with the little that had been known of the universe in the darkness of the middle ages, they required that no jot or tittle should be added to that knowledge, to hold their place secure. But this could no longer be. The time came when investigation grew active, and definite facts—angular, awkward, unpleasant facts, which (after their reprehensible manner) were irreverent enough to refuse to fit into the most sacred and deeply cherished theory—began to accumulate with startling rapidity. The result was that the old conception of things began, little by little, to fall into disrepute, and the theological edifice of ages was shaken at its very foundations. Science showed, with a conclusiveness which remained untouched by all the special pleading with which her arguments and revelations were assailed, that the popular assumptions about the age of the world were absolutely untenable; that the commencement of life, and even of human life upon our globe, so far from taking us back only a few paltry thousands of years, lay countless millions of ages behind us; and that such vague vestiges of our race as have been handed down to us in sacred book and popular legend are as nothing compared with that tremendous mass of human experiences which will never find their historian. Worse than all, turning full upon the doctrine of special manufacture, she opened up the grand geologic record, and read thence, as from the pages of a mighty volume, the long, stupendous story of those vast cosmic changes which, through æons of unreckoned time, have slowly molded and fashioned the world into the condition in which we find it to-day.

That these revelations were of the most vital interest to all thinking men needs hardly be said; nor is it necessary here to dwell on the feverish panic of the theologians, who hurried into the field with all their heavy artillery, prominent amid which was the great-gun argument, which had already done yeoman service on many another such occasion, that the very existence of Christianity was bound up with the story of creation as narrated in the first chapters of the Hebrew Scriptures.* What is here of moment is to notice the general effect of the new discoveries upon the scientific mind. That effect was at the outset almost entirely a negative one. The old theories had been destroyed, but as yet there was nothing to take their place; the theological interpretation of the world's history was seen to be absurdly insufficient and unreasonable, but for the time being no scientific interpretation in lieu thereof appeared to be forthcoming. Hence followed a kind of intellectual interregnum, during which everything was vague, shifting, tentative. Meanwhile, however, things were not by any means standing still. The unceasing activity of investigators in the special sciences resulted in vast accumulations of well-established facts, and thus yielded the materials in the absence of which nothing of real or permanent value could have been accomplished. And at the same time (largely, indeed, as a consequence of this extension upon all sides of the scientific domain) there was ever growing and deepening a conception of unbroken causation in cosmic changes, of the universality of law, and the unity of Nature and of natural processes—a conception in no small degree led up to by such discoveries as those of the undulatory theory of light and heat, and of the correlation of all the forces known to exact science. Thus, in spite of the temporary suspense and hesitation, no time was being lost. As we can now see, the way was being slowly prepared for a great scientific generalization—a generalization which, overthrowing all the old

* How fierce and obstinate was the opposition offered to the doctrine of evolution from this standpoint, we of the present day find it no easy matter to imagine. Even such a man as Hugh Miller went so far as to declare that acceptance of evolution meant nullification of the central truths of Christianity.

positions once and for all, was in the sequel to alter absolutely and fundamentally the whole trend and current of thought, not only as regards the outer organic world and the phenomena presented by it, but as regards also the countless practical problems in life and society, in morality and religion, which are forever pressing on us for solution.

Such, in the briefest possible summary, was the general intellectual character of the period at which Mr. Spencer began the labors of his life. Even the sketch just given, crude and imperfect as it necessarily is, will help us to understand the growth of his own ideas, and their relation to the changing thought of the day.

During the year 1842 Spencer, then in his twenty-second year, had contributed to a weekly newspaper, called The Nonconformist, a series of letters which were afterward republished in pamphlet form under the title of The Proper Sphere of Government. With the political doctrines of this production we have here no special concern, though it may be worth while to mention that the key-note is there struck of that famous doctrine of governmental non-interference, since so fully worked out and so frequently insisted on by the author. The pamphlet is significant for us from quite another point of view. In the attempt which is made in it to establish the nature, scope, and limits—that is, the fundamental principles—of civil government, there is everywhere implied a belief in the ultimate dependence of social organization upon natural causes and natural laws. In other words, society is from first to last regarded, not as a manufacture but as a growth—a view which, it may be remarked incidentally, though familiar enough in our own day, at all events in its theoretic aspects, was then little known, even as a matter of mere speculation. Throughout the entire argument there run the conceptions of gradual changes naturally necessitated, and of the possibility of a better and better adjustment of man, physically, intellectually, and morally, to the needs imposed by the conditions of social life. As Mr. Spencer himself wrote, many years later, "In these letters will be found, along with many crude ideas," a "belief in the conformity of social phenomena to invariable laws," and "in human progression as determined by such laws." * All this revealed, even at so early a stage of mental growth, a marked tendency to regard the complicated and entangled phenomena of society from a strictly scientific point of view—as phenomena exhibiting relations of cause and effect, and thus to be included in the realm of natural law. But it meant something more than this. The distinct and conscious acceptance of the doctrine that society is a thing, not artificially pieced together, but of slow and natural

* Reasons for Dissenting from the Philosophy of M. Comte.

growth, implied dissatisfaction with the current ideas of progress as an irregular and fortuitous process, and bore testimony to at least a vague germinal belief in a social development or evolution.

The momentous questions thus raised and briefly dealt with by Mr. Spencer in this youthful production came in for more thorough and extended treatment a few years later in his first considerable work, Social Statics, which was published in 1850, when the author was just thirty years of age. The conception of this work had entered his mind not long after the appearance of the just-mentioned pamphlet; for, owing to the rapid growth and expansion of his ideas at the time, Spencer soon became aware of the inadequacy of his handling of the various problems there opened up. "The writing of Social Statics," he has since said, "arose from a dissatisfaction with the basis on which the doctrines set forth in those letters were placed." * Even the briefest comparison of the earlier and later books is sufficient to show the enormous strides which his mind had taken during the seven critical years which divide them one from the other. In Social Statics almost everything is made to turn upon the doctrine—previously hardly more than hinted at—that from the very beginning of social life down to the present time there has been going on, and that there still is going on, a process of slow but none the less certain adjustment of the natures of men to society, and of the social organization to the natures of its constituent units: this adjustment being the result of a perpetual interaction between units and aggregate which ever tends to bring them into more perfect adaptation the one to the other. Such adaptation, it is further shown, is produced by the direct action of circumstances upon the natures of men, and by the preservation and accumulation by inheritance from generation to generation of the modifications thus initiated; though another process comes in for passing recognition—the process of the dying out of those individuals who fail to adapt themselves to the changing conditions of their environment: which process may be conversely stated as the survival of those only who so far change as to fit themselves to the necessities imposed upon them by the totality of their surroundings. Here, it will be seen, is a faint and partial adumbration of the doctrine of the survival of the fittest in the struggle for existence. Moreover, another important point is emphasized—the point that all our social evils and imperfections are due to want of complete adjustment between men and the conditions of social life—are, indeed, nothing more than the temporary jarring and wrenching of a machine the parts of which are

* Reasons for Dissenting from the Philosophy of M. Comte.

not yet brought into thorough working order. Yet, as the process of adaptation is still continuing, and is in the nature of things tending ever to produce between units and aggregate a state of more perfect equilibrium, the inevitable if optimistic corollary is, that the evil which we deplore will in the end work itself out altogether, and that eventually all friction will entirely disappear: a prophecy which seems to point to a realization of the gorgeous dreams of speculators like Godwin and Condorcet, far as the arguments upon which it is based are seen to differ from their own. Finally, all these special changes in man and in society are regarded as phases only of a process of universal development or unfolding, which is everywhere conducing, in obedience to an inherent metaphysical tendency, to the production in man, as throughout the whole of the animate creation, of more complete individuation and higher and higher types.

We thus see that, unlike Darwin and Wallace, Mr. Spencer approached the question of general evolution not from the organic but from the super-organic point of view—by the way of ethical and sociological investigations. His first conception of development was in the limited shape of progress—of development, that is, of man individually and in society. But Mr. Spencer's was not the mind to rest content with these vague and partial glimpses of a stupendous truth. Before long he began to work his way round through researches of quite a different character, toward the affiliation of these special and disjointed facts and inferences upon other facts and inferences of wider sweep and meaning.

His labors upon Social Statics had led him up to a realization of the important truth that beneath all the much-debated questions of morality and society lay the fundamental doctrines of biology and psychology; and that any really scientific or efficient treatment of man as a moral being or social unit must depend upon a thorough study of the problems of life and mind. Full of these ideas he turned with increased enthusiasm to biological and psychological studies, and to the prosecution of various lines of research in connection with these two subjects a large part, though by no means the whole, of his energies was for some time devoted.

The ten years which followed—the years between 1850 and 1860 (it is well to notice the dates, because, as we shall presently see, they have their own importance)—were years of great activity—an activity to be measured not so much by their productiveness, though that was sufficiently remarkable, as by the amazing growth and organization of ideas which took place in them. During this period some twenty-five exhaustive articles from Spencer's pen were published in the leading organs of liberal thought; and in these articles, if we take them in the order of their appearance, we can trace a gradual closing in from all sides, as it were, upon the great generalizations which were by and by to fall into their places as integral parts of a coherent system of thought. As a matter of fact, these years may be regarded, from the point of view of subsequent achievement, as years of special and methodical training; and these essays, diverse as they are in form and matter, as separate and tentative contributions toward the treatment of various isolated phenomena which were ultimately to be taken up in their interrelations and dealt with in the mass. It would be impossible here to subject these essays one by one to anything like close analysis, even if it would materially further our present purpose to do so. But a few words must be devoted to their general drift and character; and, should one or two of them be made the subjects of special mention, it will not be because these are to be considered the most important in themselves, but simply because they are the most important for the object which at the moment I have in view.

Probably the points which would most strike any one reading these essays casually and for the first time would be their strong grasp upon deep-lying principles, and their extraordinary originality. On every page they reveal, be the subject what it may, an astonishing independence of thought, and an absolute freedom from all trace of traditional methods and ideas. It was this freshness of treatment and firmness of touch which perhaps most attracted the attention of thoughtful readers when they were first published—for the most part anonymously—in the pages of the various English magazines and reviews. But, turning back to them to-day and regarding them in their mutual relations (as we are able to do now that they have long since been available in a collected and permanent form), we are impressed by something beyond the depth, clearness, and vigor of mind to which they everywhere bear witness. And that something is the essential unity of their thought, the oneness of idea which is throughout seen to underlie and inform the extraordinary diversity of materials with which they deal. It matters not whether the author is concerned with the moot questions of physiology and psychology; or with the intrinsic principles of a correct literary style; or with the changes of the sidereal system; or with ill-timed and hasty political panaceas; or with curiosities of social manners and behavior: all these subjects are systematically approached from one point of view; all are made to cluster about and find interpretation in one dominant hypothesis. And what is this hypothesis? What is this great cardinal doctrine which is thus made to weld together subjects so diverse and even so incongruous that on any merely superficial examination they would never be supposed to possess anything in common? It need hardly be said that it is the doctrine of development or evolution—a doctrine which manifests itself in every essay with continually increasing distinctness, and which is thus shown to be taking year after year a stronger and stronger hold upon the author's mind and a deeper and deeper place in all his speculations.

As early as the year 1852 he had published in a periodical entitled The Leader a short but pithy paper on the Development Hypothesis, which was afterward referred to by Darwin, in the historical sketch prefixed to the Origin of Species, as presenting the general argument for the developmental as against the special-creation interpretation of the universe with remarkable cogency and skill. But, while reasons were here briefly but clearly stated for a belief in the gradual development of all organisms, not excluding man, it must be remembered that the essay does not contain any indication of factors adequate to the production of the alleged effects. One process only is recognized—the process of direct modification by the conditions of life; and, as with this process alone it is obviously impossible to account for all the facts of organic creation, the way was left open to the uniformitarians to make good a temporary escape.

But this noteworthy little paper, though it contained a kind of systematized confession of faith, was only, after all, a starting-point for a long and thorough investigation of various aspects of the subject with which it dealt. Its leading ideas, as I have said, came little by little to suffuse all his work, and in the years which followed they underwent consolidation and reached an expression at once more definite and more complete. Was it a question of deducing a theory of population from the general law of animal fertility? Then we find distinct recognition of an advance from lower to higher brought about by excessive reproduction and the continual pressure of rapidly multiplying organisms upon the slowly increasing means of support (a statement in regard to which we shall have a word to say further on). Did the discussion turn upon the elaboration on a scientific basis of a true philosophy of style? Then, along with the application to the special phenomena of expression of the general law of "the line of least resistance," there is further reached the generalization—set down as applying to all products both of man and of Nature—of those two fundamental processes of evolution—the process of differentiation and the process of integration; since it is shown that a highly developed style "will be, not a series of like parts simply placed in juxtaposition, but one whole made up of unlike parts that are mutually dependent." * Are the right and wrong objects and methods of education brought up for consideration?

* The Philosophy of Style. First published in the Westminster Review, October, 1852.

Then the answer given is firmly established upon the doctrine of a gradual unfolding of the mental faculties in obedience to natural law, the unfolding taking the form of a double-sided change from the simple to the complex, and from the indefinite to the definite. So is it with all other subjects whatsoever. In the essay on Manners and Fashions, for example, emphasis is laid upon the truths that the various forms of restraint exercised by society as an aggregate over its individual members—such restraints being now clearly differentiated into ecclesiastical, political, and ceremonial—are all natural developments from one primordial form, and that the divergence of one from the other and of all from such primordial form takes place "in conformity with the laws of evolution of all organized bodies." And once again a similar line of argument is followed out in the extremely attractive articles on the Genesis of Science and The Origin and Function of Music. Finally, in the elaborate essay on Progress: its Law and Cause, evolutionary principles are enunciated with the utmost distinctness. The law of progress is shown to consist in the transformation of the homogeneous into the heterogeneous (a partial statement afterward completed by the addition of a factor for the time being overlooked *); and this process is illustrated by examples taken from all orders of phenomena, while the cause of the transformation is found in the law of the multiplication of effects, afterward brought out more fully in First Principles. In this essay, too, as in that on the Development Hypothesis, the general law of evolution is presented as holding good in the production of species and varieties, though here again direct adaptation to the conditions of existence is the only factor recognized as playing a part in the stupendous drama of unfolding life.

I have said enough, I think, to show how active was the period with which we have just been dealing—active alike in original production and in the absorption of fresh material and the organization of new ideas. But the enumeration of these five-and-twenty essays does not exhaust the record of Spencer's labors during this time. His studies in psychology, of which the essays on The Universal Postulate (1853) and The Art of Education (1854) were the immediate results, took more systematic form about the date of the publication of the latter paper; and in 1855 the first edition of his Principles of Psychology made its appearance. As this work was subsequently included as a portion of the two volumes on the Principles of Psychology in the synthetic system, any analysis of its contents does not fall within the scope of the present paper. Two remarks may, however, be appropriately made

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* This additional factor being increase in definiteness. A change must consist in increasing heterogeneity *and* increasing definiteness, to constitute evolution.

in the present connection ere we pass on. In the first place, it is well that we should remind ourselves how enormously this book was in advance of the whole thought of the time—not the common thought only, but the cultivated thought as well. It was in the fullest sense of the term an epoch-making book—epoch-making because it placed the study of mind, theretofore in the hands of the metaphysicians as sterile a subject as it had proved in the days of mediaeval scholasticism, upon an entirely new and promisingly fertile basis. Hitherto, mental philosophy had concerned itself only with the facts of adult human consciousness. Spencer, realizing as we are now all able to realize, how little could ever be accomplished by this time-worn and superficial method, broke away from all the traditions of the schools, and started out on an original investigation of the phenomena of mind, in the wide sweep of which he took in not only the mental growth of children and savages, but also the phenomena of intelligence as displayed by the whole range of the animate world down to the lowest creatures. To quote his own words, "Life in its multitudinous and infinitely varied embodiments has arisen out of the lowest and simplest beginnings by steps as gradual as those which evolved an homogeneous germ into a complete organism." Starting from this conception, the author proceeds to treat of the whole subject of intelligence and its forms of manifestation from an evolutionary point of view; the Principles having "for their object the establishment by a double process of analysis and of synthesis, the unity of composition of the phenomena of mind, and the continuity of their development." * My second remark is purely a personal one, yet one which has its interest and importance—though these are of a somewhat melancholy character—in any account of Mr. Spencer's earlier writings. It was in consequence of overwork while producing the volume now referred to, that Mr. Spencer suffered a nervous breakdown which completely incapacitated him for a period of eighteen months, and which, even after his general recovery, left him stranded in that condition of partial and varying invalidism in which he has continued from that day to this, and under the burden of which all his subsequent great work has been done.

It is not, I think, needful to pause, after even such a rapid summary of the activities of these ten momentous years, to say anything about the extraordinary perversion of judgment which has led critics from whom, having regard to their positions and general culture, something better was to have been expected, to treat these writings as "stock-writings," and to refer to their author as having "the weakness of omniscience" and a desire to

* Th. Ribot, English Psychology, p. 148. London, 1873.

discourse on a great diversity of subjects, from the nebular hypothesis to music and dancing. We are now, I believe, in a fair position to realize how much, or rather how little, these curiosities of oracular criticism are really worth. So far from Mr. Spencer's various essays during this epoch being merely examples of flippant journalistic versatility (as such remarks as we have spoken of would imply), we have seen how they are all united and held together by that thread of common principle and common purpose which runs through them all. Random and unrelated as they may appear to superficial or careless readers, they may, broadly speaking, be regarded as separate and methodical studies in preparation for a complete working out in general and in detail of the doctrine of universal evolution.

And now, why have I devoted so large a portion of the present paper to the consideration and analysis of these earlier, more miscellaneous, and, as it might seem, less important of Mr. Spencer's writings? Passing over the fact that in the merest sketch of the growth and development of such a mind as his we are presented with a study of which it would not be easy to overrate either the interest or the value, I may say that I had hopes of achieving two objects by following the present course. In the first place, by thus making ourselves to some extent acquainted with the progression and consolidation of Spencer's thought, we have, I think, very materially aided in fitting ourselves for the study of those ideas in the full and highly developed forms in which they appear in the pages of the Synthetic Philosophy; and, in the second place, it is by traveling together over this preparatory ground, as we have done, that we have been enabled to reach a vantage-point from which I trust it will now be easy for us to take such a survey of the general field as will help us to estimate with some degree of accuracy the real relation of Herbert Spencer to the great modern doctrine of evolution.

And this is a question upon which I would fain make myself particularly clear, because it is one in reference to which there has long been and still is current an enormous amount of misconception, not only among the mass of men and women (which would be only natural), but also, and as it seems a little strangely, among even the thoughtful and generally well informed. A vagueness and instability in the meaning of certain words in common use has been in this case, as in so many others, a main cause of confusion of ideas; another instance being thus furnished of the truth of Lord Bacon's dictum that, while we fondly suppose that we govern our vocabulary, it not infrequently happens that, as a matter of fact, our vocabulary governs us. In the common speech of the day the word Darwinism is almost invariably employed as if it were absolutely synonymous with the word evolution: the one is treated as being at all points not only coextensive but also cointensive with the other. Two noteworthy results of this indiscrimination are: first, that Darwin is habitually regarded as the author of the modern doctrine of evolution at large; and, secondly, that this doctrine has, ever since the publication of his great work on the Origin of Species, become so intimately bound up with the special views therein contained, that by the correctness or incorrectness of those special views the whole theory of evolution is supposed to stand or fall.

That this confusion, like all such confusions, has been fraught with many and varied philosophic drawbacks and dangers is a point which we need not here pause to emphasize; such drawbacks and dangers must be sufficiently patent to all. Here we are principally concerned with the entirely unjust and erroneous estimate of the historical significance of Mr. Spencer's work, and consequently of the relations of Mr. Spencer himself to the greatest of modern generalizations, which originated from or which at least has been largely kept alive by the misconception of which I speak.

To what extent this unjust and erroneous estimate has taken root, even in more cultivated thought, may be shown briefly and conclusively by one or two quotations. For example, we find the London Saturday Review remarking, in the course of an article on Prof. Tyndall's famous Belfast address, that "what Darwin has done for physiology [!] Spencer would do for psychology, by applying to the nervous system particularly the principles which his teacher had already enunciated for the physical system generally." In much the same strain, and obviously under the same impression that Mr. Spencer's ideas were all obtained at second hand,* a gentleman whom we are sorry to detect in such carelessness—Colonel Higginson—writes, "It seems rather absurd to attribute to him [Spencer] as a scientific achievement any vast enlargement or further generalization of the modern scientific doctrine of evolution." Once more, sketching out the college life of his friend, the late lamented Prof. Clifford, with whose untimely death so many brilliant promises came to naught, Mr. Frederick Pollock says, "Meanwhile, he [Clifford] was eagerly assimilating the ideas which had become established as an assured possession of science by Mr. Darwin, and were being applied to the systematic grouping and gathering together of human knowledge by Mr. Herbert Spencer." And, finally (not to weary by needlessly

* There has perhaps never been so original a thinker as Mr. Spencer who has had such a hard struggle to get or keep possession of the credit due to his own ideas. Not only is he thus reduced to the position of a mere aide-de-camp of Darwin, but many of his critics are never weary in insisting, spite of all disproof of their assertions, upon his vital indebtedness to Auguste Comte.

multiplying quotations), a man whose name is of infinitely greater weight in the world of philosophy and of letters than that of the pert critic of the Saturday Review, or the gallant American colonel, or the well-known English lawyer—a man from whom, on account of his own contributions to the study of psychology and of his wide and deep knowledge of England and English thought, a more correct judgment might have been looked for—I mean M. Taine—has thus summed up his view of Mr. Spencer's work: "Mr. Spencer possesses the rare merit of having extended to the sum of phenomena—to the whole history of Nature and of mind—the two master-thoughts which for the past thirty years have been giving new form to the positive sciences; the one being Mayer and Joule's Conservation of Energy, the other Darwin's Natural Selection."

Now, all this, to the extent to which expressly or by implication it relegates to Mr. Spencer merely the labors of an adapter, enlarger, or popularizer of other men's thoughts, is entirely false and unfounded—ludicrously false and unfounded, as the general survey of Mr. Spencer's writings which we have just taken shows beyond the faintest shadow of a doubt. So far from its seeming "rather absurd" to credit to Mr. Spencer any great personal contribution to the formulation of the doctrine of evolution; so far from his being in any sense of the term a pupil or unattached follower of Darwin, we have seen that he had worked his own way independently, from a different starting-point and through an entirely dissimilar course of investigation, to a conception of evolution as a universal process underlying all phenomena whatsoever, before Darwin himself had made public his special study of the operation of one of the factors of evolution in the limited sphere of the organic world. A simple comparison of dates will serve to make this point sufficiently clear. The first edition of the Origin of Species was published in the latter part of 1859. The essay on the Development Hypothesis appeared in 1852; in 1855—or four years before the advent of Darwin's book—there came the first edition of the Principles of Psychology, in which the laws of evolution (already conceived as universal) were traced out in their operations in the domain of mind; and this was followed in 1857 by the essay on Progress: its Law and Cause, which contains a statement of the doctrine of evolution in its chief outlines, and an inductive and deductive development of that doctrine in its application to all classes of phenomena. Spencer's independence of Darwin is thus placed beyond possibility of question.

Let it not for a moment be imagined that I am endeavoring in the slightest degree to underestimate the special value or importance of Darwin's magnificent work. Yielding him the fullest meed of praise for the great part which he undoubtedly played in the development of scientific thought, I am aiming only to show, as can so easily be shown, and as simple justice requires to be shown, that it is altogether an exaggeration to speak of him as the father of the modern doctrine of evolution. What Darwin did was to amass an enormous number of facts from almost every department of biological science, and by the devoted labor, patient examination, and long-searching thought of many studious years, to establish, once and for all, not the reality of evolution, nor even the laws and conditions of evolution, but the operation of one of the main factors of evolution—a factor which, though it had till his time entirely eluded the scientific mind, was yet required to render comprehensible a vast array of phenomena otherwise without interpretation. How near Mr. Spencer's own investigations had led him to a realization of the process of natural selection, or, as he afterward called it, the survival of the fittest in the struggle for existence, we have already been able to remark, and he himself took occasion to point out, when in the course of his later work he came to deal more systematically with the whole problem of animal fertility and its practical implications.* But the factors mainly relied upon by him, in common with all pre-Darwinian developmentalists, were the direct action of the environment and the inheritance, with increase, of functionally-produced modifications; and as these processes, whatever might be their individual importance (and this is probably somewhat underrated by scientists of the present day), were obviously incapable of throwing light upon a large part—perhaps the larger part—of the facts which pressed for explanation, the theory of evolution could not for the time being hope for inductive establishment. Darwin's book put the whole question upon a new foundation, by exhibiting a process which *did* account for the hitherto unmanageable facts; and undoubtedly it was thus to a large extent effectual in bringing the general theory into open court as an entertainable hypothesis. But while all this is freely conceded—while the greatness of Darwin's work in itself, and its importance as a contribution to scientific thought, are acknowledged without hesitation, it has still to be remembered that that work was special and limited in character, and that with the general doctrine of evolution at large it had itself nothing whatever to do. The laws of evolution as a univer-

* See Principles of Biology, vol. ii, p. 500, note. The whole of this very interesting note should be studied carefully, not only because it makes clear the scientific relations of Spencer and Darwin, but also for the foreshadowing which it contains of a reaction against that exclusive recognition of natural selection which soon became typical of biological students at large. In his little work, recently published, on The Factors of Organic Evolution, Mr. Spencer has opened the whole question up afresh, by showing that, to obtain a full view of the methods of evolution, other processes besides natural selection have to be taken into account.

sal process—a matter which the aims and objects of Darwin's work did not lead him to touch—were worked out by Mr. Spencer quite irrespective of the special process of natural selection; and when Darwin's book appeared, that process fell into its place in Spencer's general system, quite naturally, as a supplementary and not in any way as a disturbing element. Thus it appears that if any one man is to be looked upon as the immediate progenitor of a doctrine which, in common phraseology, may be said to have been to some extent in the air, that man is not he who first elucidated one factor of its process in one domain of phenomena—the biological; but rather he who first seized upon it as a universal law, underlying all the phenomena of creation; in a word, it is not Charles Darwin, but Herbert Spencer.

One word only, in conclusion, about the train of causes which immediately led up to the projection of the vast work with which Mr. Spencer's name is more particularly associated—the System of Synthetic Philosophy.

It was in 1858, while he was engaged on writing an essay on the Nebular Hypothesis, that there dawned upon him the possibility of dealing in a more systematic and connected manner than he had hitherto found possible, with those foundation principles of evolution to which he had been led by the miscellaneous studies of the past eight or nine years. The germ of thought thus implanted forthwith began to develop with amazing rapidity, and before long assumed the proportions of an elaborate scheme, in which all orders of concrete phenomena were to fall into their places as illustrations of the fundamental processes of evolution. Thus the conception of evolution presented itself to him as the basis of a system of thought under which was to be generalized the complete history of the knowable universe, and by virtue of which all branches of scientific knowledge were to be unified by affiliation upon the primal laws underlying them all. Though a rough sketch of the main outlines of the system, as they occurred to him at the time, was mapped out almost immediately, it was not till the following year, 1859—a year otherwise memorable for the publication of Darwin's book—that a detailed plan of the various connected works in which these conceptions were to be developed was finally drawn up; and not till 1860 that it was given to the small handful of readers interested in such subjects in the form of a prospectus. This prospectus included a brief summary of a proposed series of ten volumes, embracing thirty-three divisions or topics; and any one who cares to take the trouble of comparing it, as it stood when it first saw the light, thirty years ago, with the contents of the different volumes and portions of volumes which have been published up to the present time, will, I think, be astounded to observe the singular correspondence between them—a correspondence which shows how fully and accurately Spencer himself must have had the whole vast plan marked out in his mind, even down to the veriest details, before he sat down to commit himself to the penning of a single line.

And here, having followed Mr. Spencer to the verge of the great undertaking to the prosecution of which he has devoted the energies of his after-life, we draw our paper to a close; our present purpose not embracing any direct consideration of that undertaking in itself. The hope which we have ventured to entertain is, that even such a rapid review as we have thus taken of the earlier period of Mr. Spencer's intellectual activity may prove to be not altogether without its uses to the earnest student of that wonderful series of works which, by the common consent of all those most entitled to judge, have won for their author a foremost place among the greatest thinkers of all time.

SCIENCE AND FINE ART.*

By EMIL DU BOIS-REYMOND.

II.

[*Concluded.*]

ON still another side the development of photography has secured instructive data for art. In the year 1836 the brothers William and Edward Weber, in their famous work on the Mechanism of the Human Organs of Locomotion, represented a man walking in the positions which it was theoretically supposed he must go through during the time of making a step. The strange feature was remarked that while the pictures corresponded at the beginning and the end of the step, when the man for a short time had both feet on the ground, with the representations which the painters had always given of a walking man, in the middle of the step, when the moving leg was swinging by the stationary leg, the most eccentric and ludicrous spectacle was presented. The man appeared, like a drunken street musician, to be stumbling over his own feet. Never had anybody seen a walking man in such a situation. The brothers Weber proposed on the last page of their work to test the correctness of their schematic drawings by the aid of the stroboscopic slides of Stampfer and Plateau, as in the figures of Horner's dædaleum,† which has curiously come back to us from America as a novelty under the name of the zoetrope or

* Address on Leibnitz Commemoration-day in the Academy of Sciences at Berlin, July 3, 1890.

† Philosophical Magazine, etc., January, 1834, Ser. III, vol. iv, p. 36. Poggendorff's Annalen, etc., 1834, vol. xxxii, p. 650.

vivantoscope; but it is still not clear whether their purpose was carried out.

Dr. William Weber lived to see himself and his brother fully sustained, after nearly half a century, by instantaneous photography. Mr. Eadweard Muybridge, of San Francisco, applied it in 1872, at the suggestion of Mr. Stanford, to fix the attitudes of horses in the successive positions of different paces. The same phenomena were revealed in the photographs as in the Webers' schematic drawings. Pictures came out the like of which nobody believed had ever really been seen.* Directed upon street scenes, processions, etc., the camera took many views of men in quite as astonishing positions as those which the brothers Weber had attributed to them on theoretical grounds. It was not different with the wonderful series of pictures of a flying bird and its wing-strokes which M. Marey has obtained with his photographic gun.†

The explanation of these facts is evidently that, when an object moves with periodically varying velocities, we get a stronger and more durable impression of the situations in which it halts, and a weaker and more fugitive one of those in which it moves swiftly. Even without knowing this law, no painter will represent the Black Forest clock in a peasant's room with a vertical pendulum, for, if he did, every observer would ask why the clock was stopped. For the pendulum, when it has swung to one side and is about to return, necessarily stops for an instant, and this situation of pausing at one side impresses us more strongly than the one in which the pendulum is passing through its point of equilibrium with the greatest velocity. It is the same with the alternately swinging legs of the walking man: he pauses longer in the position in which both of his legs are at rest, and for the shortest time in that in which the moving leg swings in front of the resting leg. The last position and those near it, therefore, make substantially no impression upon us. We figure to ourselves the walking man, and the painter represents him accordingly in the position in which between two steps he touches the ground with both feet.

Something very curious is observed in the running of the horse. No matter how frequent the intervals at which the picture is taken, we never get the usual figure of a racing or hunting horse as it comes to us from England, and as we see it in the pictures that are hung up in the show-windows of the shops at the time of races and hunts, and as it in fact strikes our eyes on

* The Horse in Motion, as shown by Instantaneous Photography (London, 1882)—now published under the title Animal Locomotion; an Electro-photographic Investigation of Consecutive Phases of Animal Movements, etc.

† Développement de la Méthode graphique par l'emploi de la Photographie. Supplément, etc. Paris, 1885, pp. 12 *et seq.*

looking at the horse in motion. A difference may be marked here from what is the case with man; for, among the pictures of men walking, taken casually or methodically, besides those which are never seen with the eye, some also appear which correspond with the common idea of a walking man. The difference depends upon the fact that the moment in which the outstretched fore legs of the racing horse make their longer pause does not coincide with the one in which the backward-thrown hind legs do so. Both of these situations are apt to impress themselves upon the eye and blend in the resultant conception of the racer, but instantaneous photography catches them one after the other.

An American illustrated journal, in 1882, had a picture of a hurdle-race, in which all the horses appeared in real attitudes, borrowed from the Muybridge photographs, as only the fast-receiving plate can see them. Prof. Eder, of Vienna, communicated these suggestive sketches to us in a paper on instantaneous photography,* and a rarer spectacle is hardly conceivable. But when the series of pictures of a periodically moved object taken at sufficiently short intervals, whether it is presented to the eye in the dædaleum or each picture is illuminated for an instant in its passage, is well projected, the original thought of the Weber brothers is realized: the periodical motion, dissected as it were into differential pictures, is integrated again into an impression of the whole, and the accuracy of the apparently false pictures is demonstrated. The latter experiment has been worked out by Mr. Muybridge himself in his zoöpraxiscope, and among us by Herr Ottomar Anschütz, who manages instantaneous photography with extraordinary skill, in his electrical stroboscope. In both methods we see men and horses walking, running, jumping; but there is still one thing to be remarked—that is, that since the length of the passage past the eye of one of the slits of the dædaleum or of the illumination of the directly visible picture is the same for all the pictures, the appearance of the whole impression of the movement is a little different from the view of the same movement itself. That the position in which both feet of the walking man are standing nevertheless preponderates in the impression, is due to the fact that the motion of the legs becomes slower in approaching this position, so that their rapidly recurring pictures nearly cover one another.

The series of instantaneous pictures of an athlete during a severe exercise, which Mr. Muybridge and Herr Anschütz have taken, are in themselves a rich source of instruction in the representation of the nude. Herr Anschütz's stroboscope shows us the spear-thrower and the quoit-caster in the different stages of

* Die Momentphotographie. Vienna, 1870, p. 70.

their greatest strain: we see their muscles swell and contract, while at last the missile still appears in the picture after it has been thrown; for it can not move faster than the hand at the moment it leaves it. Equally useful are the instantaneous photographs of domestic and wild animals of all kinds which Herr Anschütz has taken destined to be to the animal painter.

Instantaneous photography has been applied with surprising results, as every one knows, even to the surf in storms. But the sea painter must not forget, in the use of such pictures, that our eye can not see the waves as the quickly perceiving plate does, and that one may therefore easily give us a picture of them as incorrect in some respects as that of the stationary clock or of the man stumbling over his feet.

Finally, the former method of representing lightning as a fiery zigzag is, as Mr. Shelford Bidwell has very recently shown by the evidence of two hundred instantaneous photographs, quite as false as were the old pictures of racing horses. Mr. Eric Stuart Bruce has, indeed, tried to save the zigzag lightning of the artists by seeing in it the reflection on the cumulus clouds; but we can not understand how an acute-angled zigzag can be produced in that way.*

Prof. von Brücke has in a special essay worked out the rule for the representation of motion in art,† which, like the laws of the combination of colors, has been unconsciously followed by the masters. From photography in natural colors, of which artists and laymen continue to dream and hope much, there is unhappily not only for the immediate future, but, on theoretical grounds which experience will hardly contradict, for all the future, little or nothing to be expected. There is a question whether photography will not have an unfavorable influence in the arts of reproduction, copper-engraving, lithography, and wood-engraving, whose place it is taking to a widening extent. So faithful is it that it even in a certain sense depreciates the original pictures of the old masters by making them common property.

Is it possible that it should not seem wholly superfluous to speak here of the advantage which the study of anatomy affords to the artist? Has not the Borghese gladiator suggested the conjecture of anatomical mysteries among the Grecian artists as the only means by which they could achieve so perfect a representation of the uncovered male body? Did not Michael Angelo acquire by long years of anatomical study the knowledge that justified the unparalleled boldness of his attitudes and foreshortenings of the body, which have remained to this day the object

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* Nature, etc., No. 1076, vol. xlii, June 12, 1890, p. 151; No. 1078, June 26, p. 197.

† Deutsche Rundschau, 1881, Bd. xxvi, p. 9 *et seq.*

of the admiration of naturalists like Prof. Henke and Prof. von Brücke?* Are there not institutions maintained by the state wherever art is systematically cultivated for the purpose of giving youth opportunity to train the eye on the cadaver to a clearer perception of what can be seen in the living body beneath the skin? Have not three of the later members of this Academy been commissioned in succession to give such instruction here in Berlin? Finally, have we not excellent manuals of anatomy prepared especially for artists?

But the most distinguished art-writer of our day, who assumes a tone of authority that no Lessing exercised, and who enjoys at home the honor and fame of a Lessing, Mr. Ruskin, in his lectures at the Art School in Oxford, on the Relation of Science to Art, expressly forbids his pupils busying themselves with anatomy. Likewise, in his preface, he laments the deleterious influence anatomy had on Mantegna and Dürer, in contrast with Botticelli and Holbein, who kept themselves free from it. "The habit of contemplating the anatomical structure of the human form," he says later on, "is not only a hindrance but a degradation, and has been essentially destructive to every school of art in which it has been practiced"; and he adds to this that under its influence the painter, as in the case of Dürer, sees and portrays only the skull in the face. "The artist should take every sort of view of animals except one—the butcher's view. He is never to think of them as bones and meat." †

It would be a waste of time and trouble to refute such errors, and demonstrate what an indispensable help the artist finds in anatomy, without which he would be groping as in a fog. It is very nice for him to depend upon his eyes, but still better to have learned, for example, in what the female skeleton is different from the male; why the knee-pan follows the direction of the foot when the leg is stretched out, but does not when it is bent; why the profile of the upper arm with the hand supine is different from the profile in pronation; why the furrows and wrinkles of the face run as they do in relation to the muscles beneath them. Camper's facial angle, although it has been dethroned for more important objects by Herr Virchow's basal-angle, furnishes a great deal of information. How, without acquaintance with the skull, a forehead can be modeled, or the figure of a forehead like that of the Jupiter of Otricoli or of the Hermes can be understood, is hardly comprehensible. It is true that anatomical forms may be abused by fantastic exaltation, as has been often remarked with respect to Michael Angelo's suc-

* Deutsche Rundschau, 1875, vol. v, p. 216; 1890, vol. lxii, p. 26; vol. lxiv, p. 413.

† The Eagle's Nest. Ten Lectures on the Relation of Natural Science to Art, 1887, pp. 167, 168.

cessors; but there can be no better counteractive to this Michaelangelesque mannerism than an earnest study of the real. And a little comparative anatomy protects against such faults as that which overtook a very famous master, who made a joint too many in the hind leg of a horse; or, as we see on the Fontaine Cuvier near the Jardin des Plantes, to the diversion of the naturalist, a crocodile bending its stiff neck so far back that the snout almost touches the side of the animal.

We are, however, the less astonished at Mr. Ruskin's judgment when we learn that he also lays the same ban upon the study of the nude as upon that of anatomy. It should extend, he says, no further than health, custom, and propriety permit the exposure of the body, for which the use of anatomy would certainly be limited. It is well that propriety, custom, and health permitted more freedom on this point among the Hellenes than exists in England. Fortunately, the English department of the Jubilee Exhibition four years ago gave us opportunity to satisfy ourselves that Mr. Ruskin's dangerous paradoxes had not been carried out, and allowed us to forget them in the sight of Mr. Alma Tadema's and Mr. Herkomer's magnificent contributions. Mr. Walter Crane's charming series of pictures, which adorn our book tables, have also risen up against Mr. Ruskin's absurd doctrine.

In the same lectures Mr. Ruskin assailed the theory of selection and descent with great vigor, and attacked the censure, based upon it, of artists' pictures representing vertebrates with more than four extremities. He said: "Can any law be conceived more arbitrary or more apparently causeless? What strongly planted three-legged animals there might have been! What systematically radiant five-legged ones! What volatile six-winged ones! What circumspect seven-headed ones! Had Darwinism been true, we should long ago have split our heads in two with foolish thinking, or thrust out, from above our covetous hearts, a hundred desirous arms and clutching hands, and changed ourselves into Briarean cephalopods." *

It is clear from these words that this false prophet had no notion of what we in morphology call a type. Can it be necessary to tell Sir Richard Owen's and Prof. Huxley's countryman that every vertebrate has as the foundation of its body a vertebral column, expanding in front into the skull, and contracting behind into the tail; encircled in front and behind by two bone girdles, the pectoral and the pelvic arches, from which depend the fore and the hinder extremities, regularly jointed? That paleontology has never discovered a vertebrate form divergent from this type is certainly a striking argument in favor of the theory of descent

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* The Eagle's Nest, p. 204.

and against the doctrine of special creations; for it is not easy to see why a free creating power should impose such limitations upon itself. So little does Nature vary from the once given type that teratology traces deformities back to it. None of these are real monstrosities; not even those with only one eye in the middle of the forehead, in which Herr Exner looked for the original of the Cyclops, while Flaxman erroneously gave Polyphemus three eyes, a third in the forehead, besides the two normal but blind eyes. Real monsters are those invented in the youth of art by an untamed power of portrayal—winged forms, originally derived from the East: the bulls of Nimroud, the Harpies, Pegasus, the Sphinx, the griffin; Artemis, Psyche, the Notos from the Tower of the Winds, the Victory, the angels of the Semitic-Christian cycle. A third pair of extremities (and a fourth appears in Ezekiel) is not only paratypically but mechanically absurd, for the muscles needed to move them are wanting. With happy tact, Schiller has avoided, in the Battle with the Dragon, endowing the monster with the usual wings; and Retsch in his illustrations furnished it with a form so possible in comparative anatomy that one might have fancied the plesiosaurus or a zeuglodon had returned and become a land-animal.

To the winged figures may be added, as similar abominations, the Centaurs with two chests and stomachs and double viscera, and Cerberus and the hydra with many heads on many necks, warm-blooded hippocamps and Tritons, whose bodies, without hinder extremities, end in a cold-blooded fish, a conception at the thought of which even Horace was shocked. If they had had at least a horizontal tail-paddle, one might find in them a kind of cetacean. More easily borne are the cloven-footed fauns, horns, pointed ears, and hoofs of which have been inherited by our devil, whose menaces, therefore, in Franz von Kobell's witty apology, Cuvier laughed at as those of a harmless vegetable feeder. The heraldic beasts, like double eagles and unicorns, set up no claims to art, and are protected by historical prescription against the criticism they intrinsically deserve.

It is a remarkable example of the accommodating disposition of our sense of beauty, that though we are well instructed in the principles of morphology, our eyes are not more offended by some of these false creatures, such as the winged figures of Nike and the angels; and it would perhaps be pedantic and idle to forbid artists these time-honored rather symbolical representations, of which the greatest masters of the best periods have only made a very moderate use. But such indulgence has its limits. The giants in our Gigantomachia, whose thighs change at half their length into serpents, and which, instead of two legs, stand on two vertebral columns running out into heads, with separate brains, spinal marrows, hearts, intestinal canals, lungs, kidneys, and sense-organs, are and remain an intolerable sight to the morphologically cultivated eye, and prove that, although the sculptors of Pergamon were superior in technical ability to their predecessors of the age of Pericles, they were inferior to them in refinement of artistic feeling. They were perhaps pardonable, so far as tradition bound them, for making giants with snakes' legs. The hippocamps and the Tritons with horses' legs and double fish-tails which disfigure the railings of our Schlossbrücke, come from another time, when the antique still ruled unrestrained and morphological standards were less common property than they are now. But it is a matter of deep moment to us, if a famous painter of the present suffers such monstrosities, issuing from the trunk, as sleek, sheeny salmon hardly concealing the line between the human skin and the scales, to dance realistically on the cliffs or splash around in the sea. The multitude admires such blue sea-marvels as works of genius; what a genius, then, must Höllen-Breughel have been!

Singularly enough, the primitive men in the caves of Périgord, contemporaries of the mammoth and the musk ox in France, and the Bushmen, whose paintings Herr Fritsch discovered,* only painted the animals known to them as truly as they could, while the comparatively highly civilized Aztecs outran all that is Oriental in abominable inventions. It almost seems as if bad taste belonged to a certain middle stage of culture. It follows from what we have said that anatomical instruction in art schools should not be confined to osteology, myology, and the theory of human motion, but should take pains to inculcate in the pupils—not a very hard thing—the fundamental principles of vertebrate morphology.

It should be the task of botanists to expose the breaches of the laws of the metamorphoses of plants which meet them so frequently in the acanthus arabesques, palmettos, rosettes, and scroll ornaments that are borrowed from the antique. But for obvious reasons these offenses do not afflict the student of plants so painfully as malformations of men and animals, repulsive to a sound taste, affect the comparative anatomist. Moreover, a more wholesome turn has lately come over floral ornament. When in the Renaissance the Gothic was displaced by the antique, art was impoverished of ornamental motives. The richness of invention, the *naïve* observation of Nature, of which the rows of capitals in many cloisters bear witness, yielded gradually to a conventional schematism at the base of which was nothing real. But as Rauch at Carrara, instead of the eagle of a statue of Jupiter, made

* Drei Jahre in Südafrica. Reiseskitzzen, etc. Breslau, 1868, pp. 99, 100.

his studies for the birds of his monument upon a golden eagle which was captured there, so art began about the middle of the century to free itself from this dead conventionalism, and, combining truth to Nature with beauty, applied itself again to the observation and appropriation of the world of living plants around us. Japanese art long ago struck out the right way in this region, and has been an inspiring motive for us. The minor decorations of the house, and the decorations of women's clothing, have been most happily enriched by it.

Perhaps the naturalist will be accused of a lack of logical sequence if he, in another direction, renounces regard for the laws of Nature in art. The thousand soaring and flying figures in the art works of ancient and modern times undoubtedly defy the universal and fundamental law of gravitation quite as much as the most offensive creation of a perverted fancy defies the fundamental laws, vital only in a few adepts, of comparative anatomy. Still, they do not displease us. We should rather see them without wings than with paratypical wings which could not be of use when of the usual size and without an immense muscular development. We are thus not shocked at the Sistine Madonna standing on the clouds and the figures beside her kneeling on the same impossible ground. The face of Ezekiel in the Pitti Palace is less acceptable. On the other hand, to mention later examples, in the procession of the gods hastening to the help of the Trojans, by Flaxman, Cornelius's Apocalyptic horseman, and Ary Scheffer's divine Francesca di Rimini, which Gustave Doré hopelessly tried to rival, our pleasure is not disturbed by the unphysical character of the positions. We likewise do not object to Flaxman's Sleep and Death bearing the body of Sarpedon through the air.

Herr Exner, in his admirable address on the Physiology of Flying and Soaring in Plastic Art,* tries to answer the question why these impossible representations of conditions never seen in man or beast, appear so natural and unexceptionable. I can not agree in the solution with which he seems prepossessed. He thinks that we experience something similar in ourselves in swimming, and that in diving we see persons swimming over us, as we would in flying. If we reflect within how short a time swimming has been made more general among civilized men, and how recently it has become an exercise of women, who are no less pleased with the soaring figures, doubt arises concerning Herr Exner's explanation. It would be even hazardous to appeal in a Darwinian fashion to an atavistic impression coming down from the fish age of man. And are not the sensations and the views

* Vienna, 1882.

of the skater still closer to those of a flying, soaring being than those of the swimmer? More pleasing to me is Herr Exner's remark, which I have also made myself, that under especially favorable bodily conditions we occasionally have in dreams the inspiring illusion of soaring and flying. Thus—

. . . "in each soul is born the pleasure
Of yearning onward, upward, and away,
When o'er our heads, lost in the vaulted azure,
The lark sends down his flickering lay;
When over crags and piny highlands
The poising eagle slowly soars,
And over plains and lakes and islands
The crane sails by to other shores."

Who would not ever and ever again with Faust strive to reach the setting sun and to see the still world in eternal twilight at his feet? But what we should be glad to do, we are glad to hear of in song and to see in pictures before our eyes. The longing to rise in the ether, to travel in the sky, and similar visions, still come to the help of the old delusion of mankind concerning the heavenly abode of the blessed away up in the starry canopy, to which Giordano Bruno put an end; but not so completely but that we sometimes fail to realize how terrible a journey in endless, airless, frigid space would be to us, in which even a swift, steadily flying eagle could only after long years light upon a planet of doubtful habitability.

What, now, can art do for science in return for so many and various services? Aside from external matters, like the representation of natural objects, it does not offer much of a different character from the reaction of the painter's experience in the mixing and combination of colors, on the doctrine of colors, an effect which is indeed not comparable with that of the retroaction of music on acoustics. The ancients had a canon of the proportions of the human body, attributed to Polycletes, which, however, as Herr Merkel has lately charged* applied, to the disadvantage of many an ancient work of art, only to the grown figure; a deficiency which Gottfried Schadow first systematically remedied. This theory has lately become the foundation of a very promising branch of anthropology—anthropometry in its application to the races of men.

If we extend our idea of art so as to include artistic thought and creation, there will not then be wanting relations and transitions between artist and naturalist, how far soever their paths may diverge. Yet it is not certain that an artistic conception of its problems would redound wholly to the good of natural sci-

* Deutsche Rundschau, 1888, vol. lvi, p. 414.

ence. The perversion of German science under the name of natural philosophy at the beginning of the century was as much of æsthetic as of metaphysical origin, and even Goethe's scientific efforts had the same background. This artistic comprehension of the problems of Nature is defective because it is satisfied to stop with the finely rounded figures, and does not press onward to the causal connections of the fact, to the limits of our understanding. It suffices, where it is concerned with the perceptions of the resemblances of organic forms with plastic fancies, as in the plant stem or the vertebrate skeleton; it fails when, as in the theory of colors, instead of mathematically and physically analyzing, it satisfies itself with the contemplation of presumptively original phenomena. It was reserved for Herr von Brücke to trace the colors of dark media, on which Goethe based his Farbenlehre, and which to this day spread confusion instead of clearness in many German heads, by the aid of the undulatory theory to its true source. The difference between artistic and scientific treatment is prominently set forth in this incident.*

Yet it should not be said that artistic feeling may not be of use to the theoretical naturalist. There is an æsthetic of research which strives to impart mechanical beauty in the sense in which we have defined it to an experiment; and the experimenter will not regret having responded as far as possible to its demands. At the transition-line between the literary and the scientific period of a nation's civilization, there rises, under the influence of the declining and that of the ascending genius, a tendency to a more vivid representation of natural phenomena, as is illustrated in France by Buffon and Bernardin de Saint-Pierre, and in Germany by Alexander von Humboldt, in whom it continued vital till extreme age. In this sense, as I have once said here and set it forth as a desirable end, a strictly scientific treatise may under a tasteful hand become an art-work like a novel.† The attainment of perfection in this direction will reward the naturalist for the labor, for it affords the best means of proving the faultless accuracy of the chain of reasoning comprehending the results of his observations. And in examples of this kind of beauty, which often flows unsought and unconsciously through the pen of talent, no lack will be found in our Leibnitz.—*Translated for The Popular Science Monthly from the Deutsche Rundschau.*

The deepest sounding yet found in the Mediterranean Sea was obtained by an Austrian expedition in July, 1891, between Malta and Crete, 14,436 feet. At 22½ miles southeast of this, a sounding of 13,148 feet was taken.

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* Poggendorff's Annalen, etc., 1853, vol. lxxxviii, p. 363 *et seq.* Die Physiologie der Farben. Second edition, p. 104.

† Ueber eine kaiserliche Akademie der deutschen Sprache. Reden, etc., vol. i, p. 160.

CAVE DWELLINGS OF MEN.

By W. H. LARRABEE.

STORIES of men who lived or worked in caves abound in history, mythology, and folk-lore tales. The youthful imagination is charmed with accounts of robbers' caves, from that of the forty thieves down to those described in Gil Blas and those which are associated with the robber period of the history of the Mississippi Valley. Mythology furnishes caves of giants, those to which heroes have resorted, and the homes of supernatural beings or of gnomes like the Niebelungen and the "little people." Such stories are suggested by the obvious fact that a cave may afford a safe and convenient place of refuge when no better is at hand; and their imaginative features are the outcome of the rarity or remoteness of experiences of cave-life within historic times—distance lending enchantment to the view.

Tribes of cave-dwelling men, or troglodytes, are described by ancient writers as having lived in Egypt, Ethiopia, on the borders of the Red Sea, and in the Caucasus. The Red Sea region was called by the Greeks from this fact *Troglodytice.* Some of the ancient caves in Arabia are still occupied by Bedouins.

The caves of the troglodytes near Ain Tarsil, in Morocco, which have been visited by Balanza and Sir Joseph Hooker, and described by a correspondent of the London Times, are situated in a narrow gorge, the cliffs of which rise almost perpendicularly from a deep valley, and are cut in the solid rock at a considerable height from the ground. In some places they are in single tiers, and in other places two or three tiers, one above the other, and inaccessible except by ropes and ladders. The entrances give access to rooms of comfortable size, furnished with windows, which were in some cases connected with other smaller rooms, also furnished with windows. The appearance of the caves, attesting that great pains were taken to secure comfort, is hardly consistent with the conception of the troglodytes as savages, which has been drawn from Hanno's account of them. Caves have been much used for burials, and have suggested the form of various artificial burial-places. The ancient Egyptians used natural caves or hollowed out artificial ones, preparing elaborate suites of chambers, antechambers, and recesses, and adorning them with brilliant paintings and art-works of religious significance. The recovery and exploration of these tombs constitute one of the most interesting and profitable branches of modern archæological research. The most ancient real-estate transaction recorded in a historical book is the purchase of the cave of Machpelah from the children of Heth by Abraham, to be his family burial-place; and it is still guarded as such at Hebron by a Mohammedan mosque, which only the children of the faith and no infidel can pass.

Remarkable vestiges of the cave-life of antiquity may be seen in the rock-hewn city of Petra in Edom, some fifty miles south of the Dead Sea. The valley in which it stood is lined on either side with the remains of tombs, temples, and perhaps habitations, excavated out of the rock. These structures are supposed to date from a remote antiquity. In later times they were faced with architectural fronts of a more or less imposing character. They are believed to have been used chiefly as places of burial. But there is reason to suppose that most of them were originally intended and used as habitations. Many of the chambers have no resemblance to tombs, but are such as a primitive race would construct to live in. Most of these have closets and recesses suitable for family uses, and many have windows in front, which would be superfluous in tombs. It may be that in the course of time, as customs and people changed, these chambers were abandoned for other houses, to be subsequently used as places of sepulture.

Evidences are found in caves the world over of their use by prehistoric men from the stone ages down—so frequently as to indicate that they were at one or more periods the usual dwellings of the race, and archæologists have based upon them the type or types of cave-men. The evidences of human abode are often found mingled with traces of animals, some of extinct species, which seem to have shared man's occupancy or contested with him for it, or to have possessed the caves alternately with him. They have furnished fruitful fields for archæological and geological research, and the excavation of them has afforded valuable information concerning the condition and surroundings of the most primitive men, and incidentally as to the age in which they lived. The most noted localities where the earlier finds of ancient stone implements were made in France were habitations of cave-dwellers or in the immediate vicinity of such habitations, and the science of palæolithic archæology was thus based in its beginning upon the relics left by men of this type. In Kent's Cavern, Torquay, which was one of the first of these palæolithic abodes to be studied in England, human bones or articles of human manufacture have been found in two or three different strata, the oldest ones under conditions betokening extreme antiquity and in company with the remains of animals that were extinct long before the historical period. The first discoveries here were among the earliest evidences that were obtained of man's having had a greater antiquity than had till then been ascribed to him, and were received incredulously by a public which the thought struck as contradictory to revelation. The cave was examined year after year by scientific committees. The findings were confirmed, and shown to be in place and so situated as to forbid the supposition of the human remains being of more recent origin than the accompanying deposits. Similar remains have been found in many caves in all countries, and now consti-

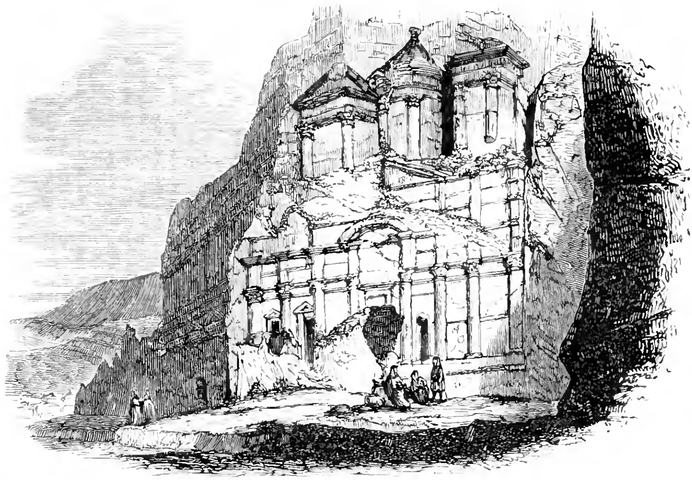


FIG. 1.—CORINTHIAN TOMB AT PETRA.

tute only one among several kinds of evidences of man's glacial and preglacial existence. A cave at Cravan, near Belfort, France, appears to have been extensively used as a prehistoric burial-place of the polished-stone period. It contained a number of skeletons in such positions as suggested deliberate arrangement, and with them were beautifully ornamented vases, polished-stone bracelets, and a mat of plaited rushes. The cave of Marsoulas, in the Haute-Garonne, France, was inhabited by man several times during the palæolithic age. The relics of what is designated as the second occupation are interesting on account of the specimens of artistic taste they afford. Besides the usual instruments of silex, arrow-points, and the like, were found some peroxide of manganese, which was probably used in tattooing, and engraved designs; a piece of bone adorned with a regular ornamentation, engravings very much like those found in the valley of La Vézère; and a piece of rib having an *ovibos* (or musk ox) carved upon it, in which, according to the Marquis de Nadaillac, the design is treated with exact knowledge of anatomical forms, the relief is brought out by shadings, and the drawing is vigorous. One of the recent excursions of the French Association for the Advancement of Science took in its way the grottoes of Lamouroux and Montrajoux, near Brive. The grottoes of Montrajoux are natural and have been used as the abodes of shepherds' families since the age of the reindeer. Those of Lamouroux are the work of man, as is attested by the marks of the pick which they still bear. They are grouped in line and arranged in different stories which communicate with one another, there being in some places five stories. Some were distinguished by benches in the back, bearing tying-holes on their edges, which suggested that they had been occupied by the domestic animals. The situation of these grottoes in the neighborhood of the Château of Turenne, crowning the heights, induces the supposition that they served as places of refuge for Protestants during the religious wars. The bone caves of Borneo appear to have been occupied by men who were acquainted with the use of manufactured iron. The remains have recently been discovered on the banks of the Amu Daria or Oxus River, in central Asia, of a considerable city which was composed of caverns hewn in the rock. It seems, from the inscriptions, coins, and other objects found in it, to have been in existence in the second century of the Christian era. Some of the houses were of several stories.

Dr. Arthur Mitchell, of Edinburgh, in a lecture delivered a few years ago on the condition and antiquity of the cave-men of western Europe, showed—of the men of the caves which he had

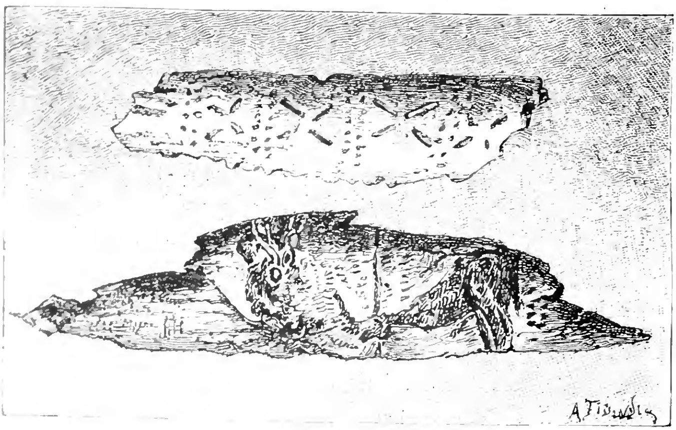


Fig. [illegible].—Upper figure—a piece of bone, bearing regular designs. Lower figure—a piece of rib, with an ovibos engraved upon it. Both found in the grotto of Marsoulas (Haute-Garonne).

particularly in mind—that their weapons of war and the chase were made of bone or horn, and highly finished, while their implements of stone were extremely rude and calculated chiefly to serve as tools in the making of their bone implements, so that they were placed in the bone rather than the stone age of civilization. From an elaborate examination of the objects which the cave-man has left, displaying an art faculty, and from the study of the crania of the cave people themselves, he argued that they must have possessed a high capacity for culture in all directions, and must have been as complete in their whole manhood as living Europeans. He was disposed to put their age only a few thousand years back.

The cave temples of India are famous and most curious specimens of architecture. They date from near the beginning of the Christian era. The best-known ones, those of Elephanta, have been described and pictured over and over again. The great cave, according to Mr. James Burgess, in The Rock-cut Temples

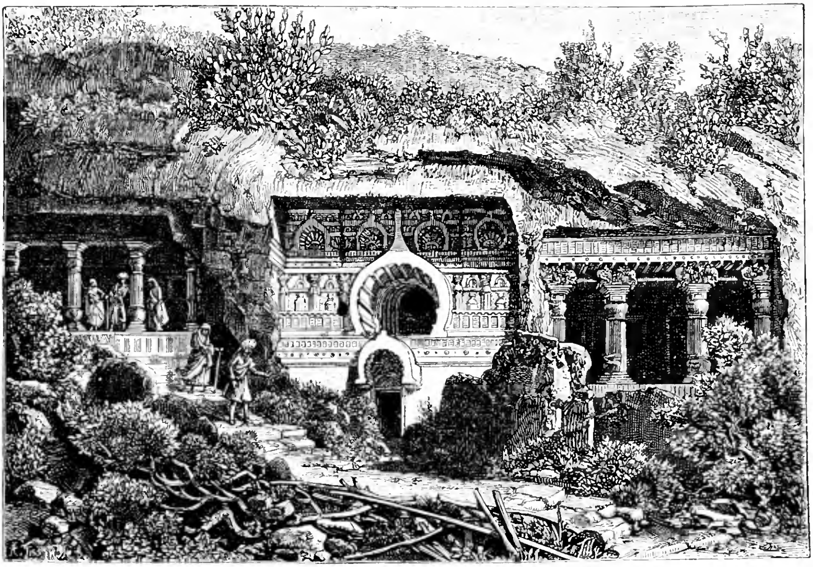


Fig. 3.—Façade of the Temple of Pandu Lena, near Nassik, India. (From a drawing by M. Albert Tissandier.)

of Elephanta or Ghârâpuri, occupies a space having an extreme length of two hundred and sixty feet, with a depth into the rock of a hundred and fifty feet. It has three entrances—one in the side and one at each end—which are each about fifty-four feet wide, and divided into three doors by pillars fully three feet in diameter and sixteen feet high. This subdivision is repeated over the entire area of the underground temple, which may be described as consisting of eight parallel rows of such columns about fifteen feet apart. One of the quadrangular clumps of pillars is built round and incloses the shrine. Opposite the north entrance is the Trimusti, or Trinity, one of the most remarkable sculptured religious relics in the world. It consists of three united half-length figures, each head being elaborately carved and ornamented, and is seventeen feet high and twenty-two feet wide. Besides the great caves there are three others on the island. They consist of a central excavation for the shrine, usually about twenty feet square, with attached cells or apartments for priests, two, four, and six respectively in number, each about sixteen feet square. The tem-

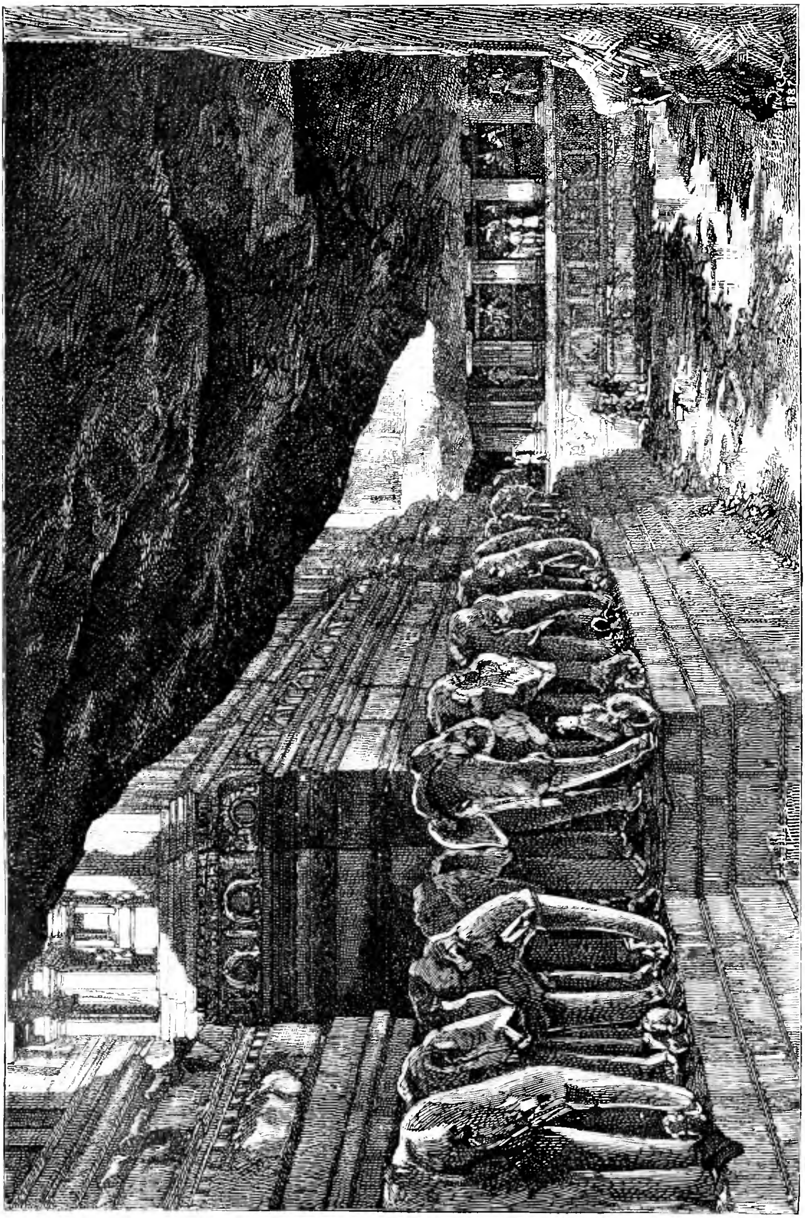


Fig. 4.—The Temples of Kylas, Ellora, India. (From a drawing by M. Albert Tissandier.)

ples of Pandu Lena, constructed, according to the inscriptions they bear, about 129 B. C., are remarkable for the profusion and perfection of their ornamentation, which, like that of the cave temples generally, seems to be designed to imitate constructions of wood. Those of Ajunta consist of four temples and twenty-three monasteries, built in the face of an almost perpendicular cliff. They were begun about 100 B. C., and have remained in the condition in which they are now seen since the tenth century. They are excavated *en suite* in the amygdaloid of the mountain, and are described as being of grand aspect, upheld by superb columns with

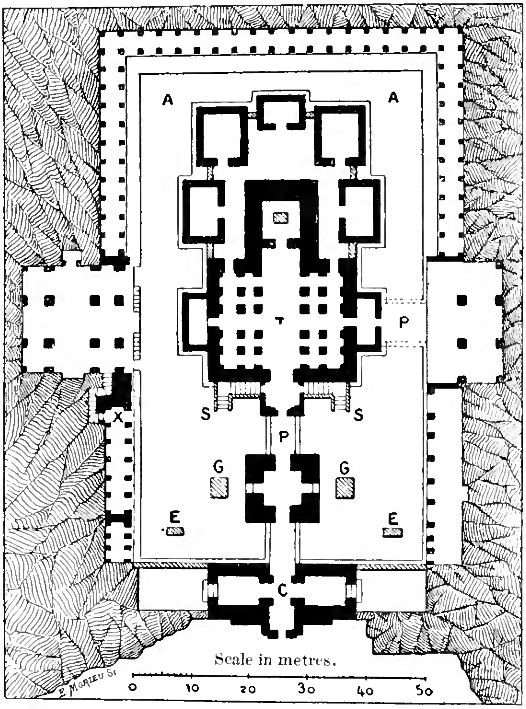


FIG. 5.—PLAN OF THE TEMPLES OF KYLAS.

curiously sculptured capitals and adorned with admirable frescoes reproducing the ancient Hindu life. The temples of Ellora are of different construction. Built in a sloping hill, it was necessary, in order to obtain a suitable height for the façade, to make a considerable preliminary excavation. In the group of these temples known as the Kylas, according to M. Albert Tissandier, the excavation has been carried around three sides, so as to isolate in the center an immense block, in which a temple with annexed chapels has been cut. The buildings are thus all in the open air, carved in the form of pagodas. Literally covered with sculptures composed with consummate art, they form a unique aggregate. They appear to be placed upon a fantastic sub-base on which all the gods of the Hindu mythology, with symbolical monsters and rows of elephants, are sculptured in *alto riliero,* forming caryatides of strange and mysterious figure, well calculated to strike the imagination of the ancient Hindu population. The interior of the central pagoda is adorned with sixteen magnificent columns, which, as well as the side walls, were once covered with paintings; and, with the central sanctuary of the idol, is composed with a correct understanding of architectural proportions. The two exit doors open upon a platform on which are five pagodas of lesser importance but of architectural merit and artistic ornamentation corresponding to those of the main building. Around these isolated temples excavations have been made into the sides of the mountain, in which are found a cloister adorned with bas-reliefs representing the principal gods of the Hindu pantheon; other halls, likewise sculptured; and various other features implying great labor and refined artistic taste and skill.

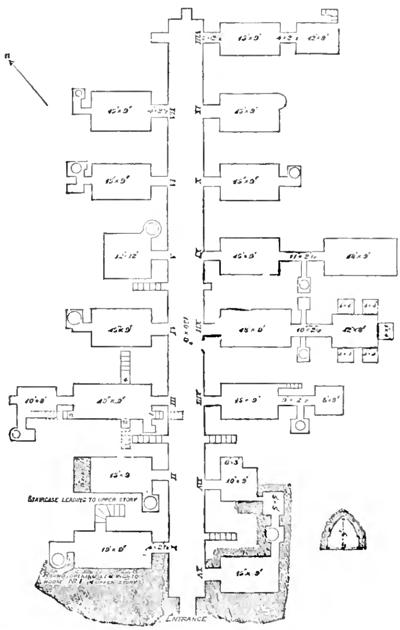


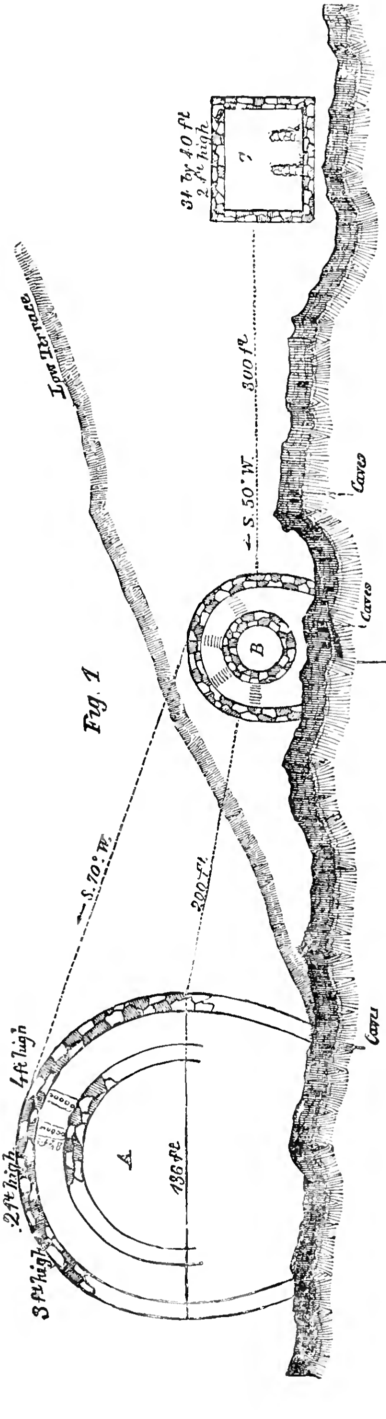
Fig. 6.—Yaki Deshik Caves of Afghanistan.

At Bamian, in Afghanistan, are five colossal statues (probably Buddhas) seated in niches which have been dug out in the cliff, while the rock is pierced with caves which are supposed to have been excavated by Buddhist monks during the first five centuries of the Christian era. Many of the caves are inhabited. Some of them are shown to have been bricked up in front, and both niches and caves are adorned with paintings and ornamental devices. Captain F. de Laessoe has described a number of caves which were excavated for habitation in the sandstones of the right bank of the Murghab River, near Penjdeh, in Afghanistan. One of them (Fig. 6) consists of a central passage a hundred and fifty feet long and nine feet broad and high, having on each side staircases and doors leading to rooms of different sizes. Each room has attached to it a small chamber, with a well in which possibly water brought up from the river was stored; and is also provided with small niches in the walls on which the lamps were placed and where marks of soot can still be seen. The entrances from the main passage to the rooms were shut with folding doors on wooden hinges, of which the socket-holes of the hinges and holes for the admission of the arm behind the door to draw back the bolt are the only traces now to be seen. This structure had an upper story, but much less extensive than the lower story. Many other caves, similarly constructed but containing fewer rooms, are found all along the valley. At one of them the cliff is so well preserved as to show how access was gained. It was by means of holes cut in the rock for steps, which could be easily climbed by the aid of a rope hanging down from above.

Vestiges of cave dwellings are very abundant in America, but they have not been made the subject of special study to so great an extent as those of Europe. They are prehistoric, ancient, or relatively modern, and represent various stages of civilization in those who inhabited them. Some are found as far north as Alaska, where, according to Dr. Peet, who has published in the American Antiquarian excellent illustrated summaries of the results of the explorations of the cliff and cave dwellings, "they are associated with shell-heaps; others in the Mississippi Valley, where they are closely connected with the mounds; others in the midst of the cañons of Colorado and Arizona, where they are associated with structures like the Pueblos; others in the central regions on the coasts of Lake Managua, in Nicaragua; and still others in the valley of the Amazon in South America." According to Mr. William H. Dall, the cave-dwellers of Alaska were neolithic. The caves in Tennessee are described by Prof. F. W. Putnam as containing tokens of a neolithic character; but it is uncertain whether they preceded the mounds or were contemporaneous with them. Dr. Earl Flint has described caves in Nicaragua which strike him as being very ancient; and certain caves in Brazil are supposed to be palæolithic.

The most interesting of the American cave dwellings, and those which have received the most attention, are those which are associated and almost confounded with the cliff dwellings of the cañons of Arizona and Colorado. So nearly related are the cliff and cave dwellings of this region, in fact, that it seems to have been to a considerable extent a question of the shaping of the rock whether the habitation should be one or the other. Regarding the two as a whole, they were very numerous, and indicate the former existence of a large population. Major Powell is quoted as having expressed surprise at seeing in the region nothing for whole days but cliffs everywhere riddled with human habitations, which resembled the cells of a honeycomb more than anything else. Yet it is probable that only a small fraction of these singular dwellings have been seen, while the number of those that have been even only superficially explored is much less.

An excellent, finely illustrated description of some of these



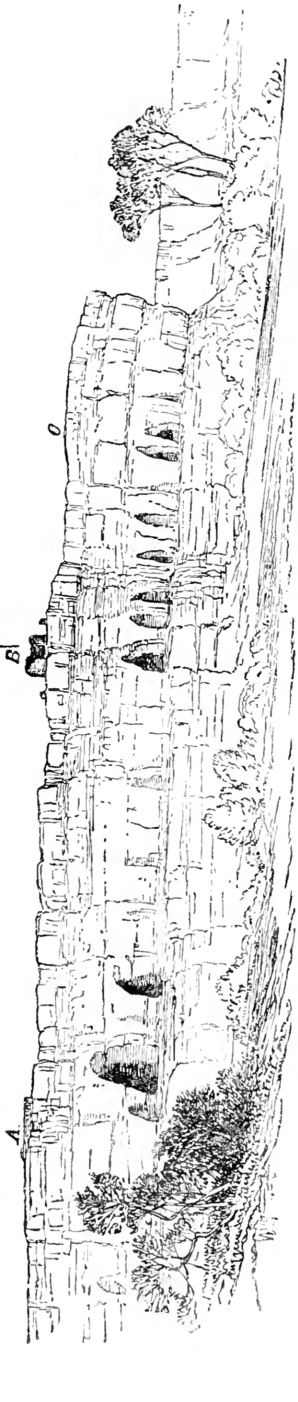


Fig. 7.—Cave Dwellings in the Rio San Juan.

ancient dwellings in the Rio Verde Valley was given, from his own personal observations, by Dr. Edgar A. Mearns, in The Popular Science Monthly for October, 1890. But his attention was devoted chiefly to the buildings in exposed situations of the Pueblo style of architecture; while he speaks of having seen lines of black holes emerging upon the narrow ledges, which he was told were cave dwellings of an extinct race. He mentions also walled buildings of two kinds—those occupying natural hollows or cavities in the face of the cliffs, and those built in exposed situations; the former, whose walls were protected by sheltering cliffs, being sometimes found in almost as perfect a state of preservation as when deserted by the builders, unless the torch has been applied. "Another and very common form of dwellings," Dr. Mearns continues, "is the caves which are excavated in the cliffs by means of stone picks or other instruments. They are found in all suitable localities that are contiguous to water and good agricultural land, but are most numerous in the vicinity of large *casas grandes*."

The cave dwellings are more prominent in other accounts of the region, and seem to be a very important feature in some of the cañons. The majority of those known are in the valleys of the Colorado and the Rio Doloroso, Rio San Juan, and Rio Mancos, its tributaries. A village, if we might call it that, on the San Juan, described by Mr. W. H. Holmes, is surmounted by three *estufas* or towers, one rectangular and two circular, each over a different group of cave dwellings. A short distance from this ruin are the remains of another tower, built on a grander scale. These structures are supposed by Mr. Holmes to have been the fortresses, council chambers, and places of worship of the cliff and cave dwellers.

The great Echo Cave on the San Juan is described by Mr. W. H. Jackson as situated on a bluff about two hundred feet high, and as being one hundred feet deep. "The houses occupy the eastern half of the cave. The first building was a small structure, sixteen feet long and from three to four feet wide. Next came an open space, eleven feet long and nine feet deep, probably a workshop. Four holes were driven into the smooth rock floor, six feet apart, probably designed to hold the posts for a loom. . . . There were also grooves worn into the rock where the people had polished their stone implements. The main building comes next, forty-eight feet long, twelve feet high, and ten feet wide, divided into three rooms, with lower and upper story, each story being five feet high. There were holes for the beams in the walls, and window-like apertures between the rooms, affording communication to each room of the second story. There was one window, twelve inches square, looking out toward the open country." *

* Dr. Stephen D. Peet, in the American Antiquarian.

There were also holes in the upper rooms, which may have been used for peep-holes. Beyond these rooms the wall continued one hundred and thirty feet farther, and the space was divided into rooms of unequal length. The appearance of the place impressed Mr. Jackson as indicating that the family were in good circumstances. These are single specimens of a class of dwellings of which there are probably many hundreds. The ages of these dwellings and the conditions under which they were built and

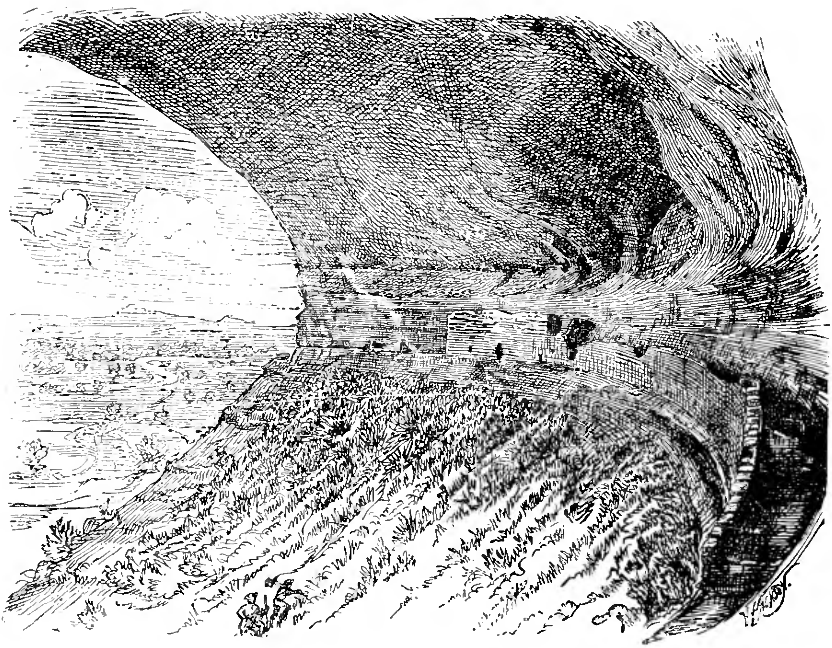


Fig. 8.—Echo Cave on the Rio San Juan.

occupied are unknown. The climate favors the preservation of objects, so that they may be of considerable antiquity; and there is no reason for supposing they were not inhabited down to a comparatively recent period. The objects found within the cliff and cave dwellings, some of which are represented in Dr. Mearns's article, indicate a considerable degree of civilization.

An account was published by Mr. Theodore Hayes Lewis, in Appletons' Annual Cyclopædia for 1889, of some curious drawings that are found in caves at St. Paul, Winona, and Houston Counties, Minn., La Crosse County, Wis., and Allamakee County, Iowa. They include representations of the human form, fish, snakes, animals, and conventional figures.

Many accounts of travelers go to show that residence in caves is not rare in modern times, and that it constitutes a feature of life, though not an important one, in some of the most civilized countries in Europe. Some of the most interesting pages in Mrs. Olivia M. Stone's account of her visit to the Canary Islands (Teneriffe and its Six Satellites) relate to the cave villages, still inhabited by a curious troglodyte population—mostly potters—found in various places in Gran Canaria. Appositely to an account by the Rev. H. F. Tozer of certain underground rock-hewn churches in southern Italy, Mr. J. Hoskyns Abrahall relates that when visiting Monte Vulture, and while a guest of Signor Bozza, at Barili, having expressed surprise at learning the number of inhabitants in the place, his host told him that the poor lived in caves hollowed out of the side of the mountain, and took him into one of the rock-hewn dwellings; and he accounts for their existence by the facility with which they are formed.

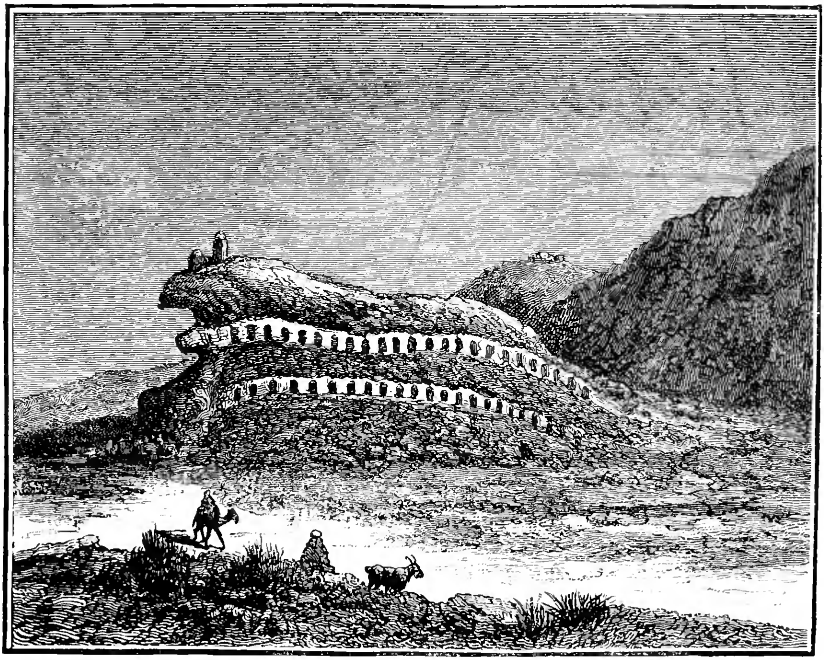


Fig. 9.—Gh'mrassen, in the Ourghemma, Southern Tunis, with the Rock-cut Dwellings.

The rock-cut village of Gh'mrassen, in the Ourghemma, southern Tunis, consists of rows of snug family dwellings, close to each other, hollowed out of the side of a cliff, the top of which at an overhanging point, is crowned by the remains of a small mosque.

At a recent meeting of the Royal Geographical Society of Madrid, Dr. Bide gave an account of his exploration of a wild district in the province of Caceres, which he represented as still inhabited by a strange people, who speak a curious *patois*, and live in caves and inaccessible retreats. They have a hairy skin, and have hitherto displayed a strong repugnance to mixing with their Spanish and Portuguese neighbors. Roads have lately been pushed into the district inhabited by these "Jurdes," and they are beginning to learn the Castilian language and attend the fairs and markets.

Some disused rock-hewn dwellings are mentioned in Meyer's Guide-Book as existing near the ancient Klusberg in the Hartz

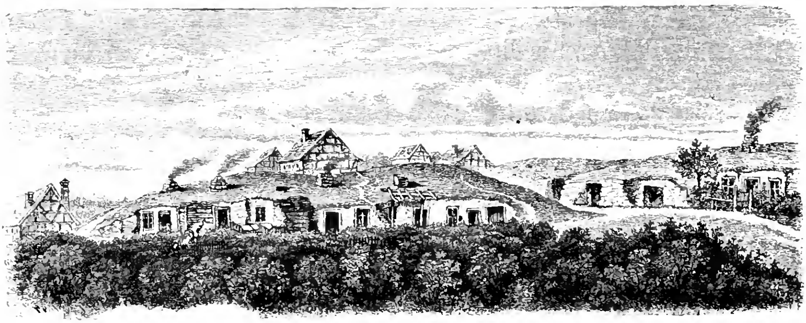


Fig. 10.—Cave Dwellings near Langenstein, in the Hartz Mountains. (From a drawing by E. Krell.)

Mountains. Herr E. Krell describes in a German periodical a group of such dwellings, now inhabited, near the village of Langenstein in the same region. There are some twenty of them, each furnished with a door and a window, and inhabited altogether by about forty persons. The oldest of them was made about thirty years ago, by a poor, newly married couple who found the conditions of life in the village too hard. It was gradually enlarged, by patient excavation in the rock, until it has been made a comfortable and convenient dwelling. The house has a neatly kept entrance, with a hallway, a living-room on the right, in which is the only window, a bedroom on the left of the hall; in the rear a spacious store-room on the left, and a kitchen with a fireplace on the right; and behind the kitchen another bedroom. The chimney is carried up through the roof, and where it comes out above the surface of the ground is well guarded with a wall of stones. Although the back rooms are not directly lighted from without, they receive sufficient

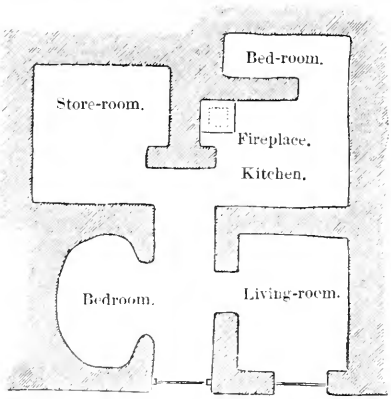


Fig. 11.—Plan of a Cave Dwelling near Langenstein.

light from the front; the houses, as a whole, are dry, warm in winter and cool in summer, and do not suffer from lack of ventilation; and their inhabitants, as a rule, are a healthy and vigorous people. Some of the proprietors have whitened the fronts of their dwellings, and have planted gardens in the ground over them and in front of them, so as to give their homes a not unpleasing air; and the cave dwellings are much drier and more healthful than city basements.

Another group of inhabited caves is described in La Nature by M. Brossard de Corbigny as stretching for the length of a kilo-

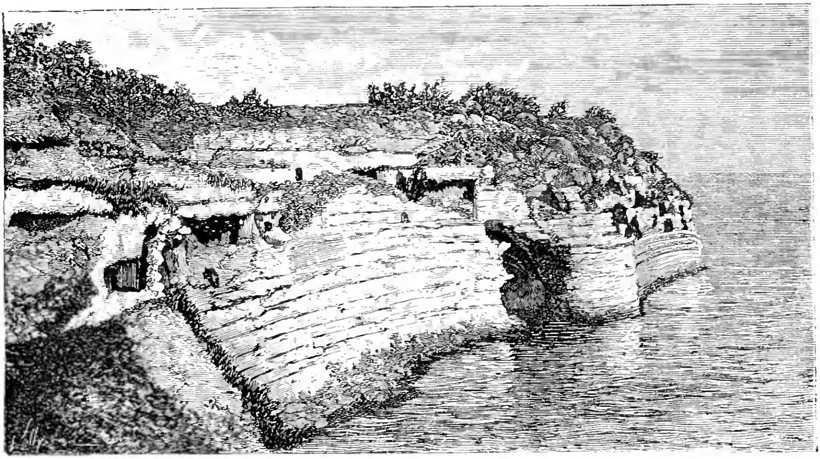


Fig. 12.—The Grottoes of Meschers, in the Bluff, Charente-Inférieure, France. (From a water-color sketch by M. Brossard de Corbigny.)

metre along the right bank of the river Gironde, at Meschers, in the Charente-Inférieure, France. "They are excavated in a high bluff of shell-rock, which is crowned above them by a number of windmills, some still active while others are disused, and face the broad river, commanding a view of the sea and the Cordouan Tower in the distance. The caves are partly natural and partly the work of man. They can not be seen from the top of the bluff, and are accessible by goat-paths descending from the mills—not very pleasant walking for women and children, especially where it has been necessary to cut stepping-notches in the rock. Not all the paths are equally difficult of descent, and some leading to the stations of the lobster-fishers go down to a kind of ladder that reaches to the water's edge. Whatever path one follows, he is sure at about a third of the distance down to come upon an excavation suggesting the nest of some gigantic sea-bird of the olden time; but he will soon observe that the bottoms of the caves and the roofs have been made smooth by the hand of man, while the great openings looking out upon the sea bear marks of erosion by the southwest winds and the rains. Most of these grottoes were inhabited fifty years ago, but the majority of them have been abandoned in consequence of the land-slides and the development of the knowledge and desire of a better way of living. Three of them are still occupied by persons who boast that they are very comfortable in them—warm in winter with their southern exposure and complete protection from the north, and enjoying a refreshing coolness in the summer. The caves are free from moisture, and cost no rent except a slight fee paid to the proprietor of the ground above them. The natural opening on the side of the sea is closed not very tightly with boards or stones, in which one or two windows admit a sufficient light. The house is usually composed of two rooms, separated by a partition which was left in the hollowing out of the cave, and the furnishings are as comfortable as those possessed by the majority of the peasants of the

Fig. 13.—Entrance to the Grotto La Femme Neuve, Meschers.

region. Other shallower cavities outside of the main ones serve as sheds for the wood which is used to cook, in earthen kettles, the soup and the fish and oysters which are found in abundance at the foot of the bank. The visitor who expects to find misery or signs of hard life in these grotto homes will be disappointed; instead, he will see people as satisfied with their lot as Diogenes was with his tub.

"If we desire to visit these grottoes, we may descend from one of the windmills by a winding path to the one called *Femme neuve*, because it is the newest of the group. We are welcomed with the best the proprietor has to offer. The women are busy with their washing. The smoke escapes freely through the loose planks of the sea-wall. A second chamber serves as a sleeping-

Fig. 14.—Interior View of the Grotto La Femme Neuve, Meschers.

room and is furnished with two beds, a commode, and, opposite the beds, the fireplace, back to the sea, between two small glass windows. During high southwest winds the spray leaps up to the height of the caves, the rain dashes against the planks, the grottoes are inundated and made uninhabitable, and it becomes necessary to seek shelter in some of the cottages of the village.

"Another path from the windmills leads to a second grotto, where lives Father Lavigne, a bright and sprightly man of about eighty years, who makes a weekly trip to Royan and back in the same day. He receives his visitor with great courtesy, hat in hand, and shows him his two rooms, nearly bare, but commanding a fine view over the gulf and the sea. His furniture is simple but neat; and the old gentleman, who has lived here more than forty years, declares that he is quite happy, for health is left to him. His cave-life has never given him rheumatism.

"A locksmith and knife-grinder has recently established himself in a third cave, and has the love of a hermit for it. His door and window are open, showing a single room with a bed of straw on four legs, a wall-table, a few utensils, and a chair, as all the furniture. In one corner are a grindstone and a forge, the arrangement of which shows how much an ingenious man can do with the most primitive materials. The proprietor has traveled extensively in the exercise of his trade and has seen much of the world. Now, at forty years of age, he seeks rest, and the embellishment

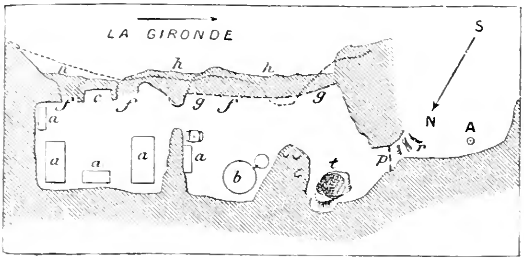


Fig. 15.—Plan of the Grotto La Femme Neuve, Meschers: *a*, beds and closets; *b*, wash-tub; *c*, fireplace; *f*, windows; *g*, vertical planks forming a partition on the broad side; *h*, rim of vertical rocks twenty metres above the sea; - - - - edge of the floor; *p*, door; *r*, ladder ascending to the top of the cliff; *t*, water-hole.

of his home is his ruling desire. He communicates his plans enthusiastically to his visitors. He has planted white gilliflowers under his window, the only kind, he says, that will bear the sea winds. Next year he will plant a grape-arbor, the vines of which he will carefully protect against too severe exposures.

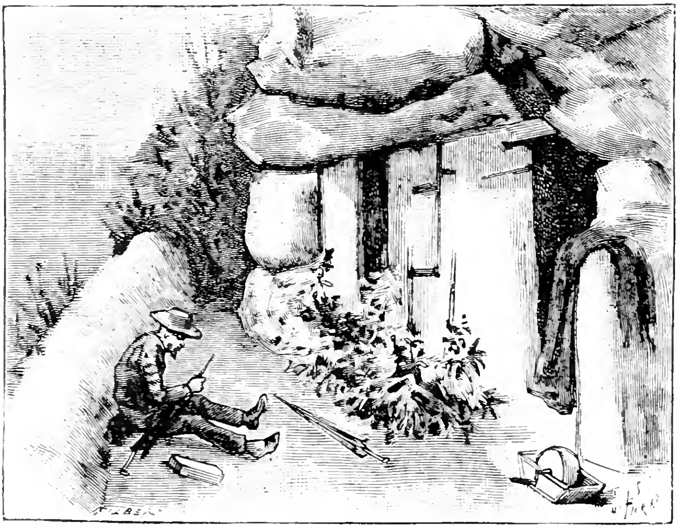


Fig. 16.—The Knife-grinder's Cave at Meschers.

"Other grottoes have been acquired by persons in easy circumstances, remodeled, partitioned off, and even fancifully papered. They are simply the pavilions of citizens, and there is no interest in visiting them." At the foot of the bluff on the eastern side are large regular cavities which are said to have been the refuge of Protestants during the religious wars. They were afterward converted into quarries, from which a soft shell stone was obtained. The places are still to be seen where the barges landed at the entrance of the quarries, and the older people of the country remember when they were worked.

For specimens of modern cave dwellings in the United States we might turn to the sod-houses of the Western plains, which the settlers construct for temporary shelter while waiting for a supply of lumber with which to build a more conventional if not better house. They can not, however, be classed with the permanent dwellings which this paper has held in view. As soon as the new house is done, they are turned over to the cattle and pigs, or abandoned and left to the mercy of the elements.

EVOLUTION IN FOLK LORE.

AN OLD STORY IN A NEW FORM.

By DAVID DWIGHT WELLS.

TO the historian folk lore is both a blessing and a curse. It presents an almost insurmountable barrier to scientific investigation; for, to separate the kernel of truth from the mass of superstitious chaff by which it is surrounded, is a task in comparison with which the proverbial finding of the needle in the hay-stack sinks into insignificance. Viewed in another aspect, however, folk lore is of the greatest importance to the inquirer in the past, for it forms the connecting link in the evolution of a tribe, a race, or a nation.

Long after a people has passed away as a unit, its traditions will survive, and, wherever they may be found, they will point conclusively to the existence of some portion of that race. The legend, however, seldom retains much of its original form, and this is not to be wondered at. Common experience teaches us daily how a story can grow in the mouths of men, and when it comes to be a matter of generations and not of days, it naturally undergoes many marked changes. The legend or folk-lore story adapts itself also to its surroundings, which, parasite-like, cling to it so effectually that often it is extremely difficult to distinguish the original legend in its corrupted form.

These changes are especially noticeable when the race or tribe has migrated from one country to another, and a careful study of the alterations which take place in the typical legends of a people illuminates the history of the race itself.

It is not my intention to enter into any such elaborate undertaking; but merely to present to the public a curious example of an evolution of folk lore which has come to my notice, and trace its passage for a few generations.

This story came to me from a gentleman who was born about the beginning of this century in Essequibo, British Guiana, South America. His father was an English planter, and owned estates and slaves. Brought up, as was the narrator, among these slaves, he heard from them many of the traditions of their race, which his excellent memory preserved in their original entirety. Perhaps the most pleasing of these which his kindly spirit prompted him to relate for the amusement of children, and the only one of which I have any clear recollection, was—

The Story of the Hunter.—Once upon a time a hunter lived in a little hut on the edge of a great wood in Africa. He lived by himself, for his father and mother had died many years before, leaving him nothing but the hut in which he dwelt, and three magic arrows, which he was only to use in time of great danger. This hunter had two very large and fierce dogs—one called Ya-me-o-ro, and the other Con-ga-mo-ro-to—which followed him everywhere he went. In this wood was a great herd of white cows, which the hunter killed when he had need of meat, and whose skins he dried and made into clothes. These cows hated the hunter, and would have torn him in pieces many times, had it not been for his faithful dogs, that always hunted with him, and which the cows feared to attack. So the hunter lived peacefully, and for many a day all went well with him.

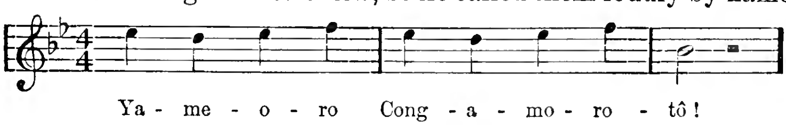
One evening about sunset the hunter, while seated in his hut, heard cries and groans coming from the woods; and, taking his dogs, went out to find the cause of them. He had not gone far when he came upon a fair, strange woman, lying upon the ground, apparently in great distress. She was tall and slender, and more beautiful than any one that he had ever seen. When she saw him she begged for food and shelter, saying that she was dying of hunger and thirst, and had fallen fainting where he had found her. The hunter carried her back to his hut, and nursed her as tenderly as he could until she became well and strong again. When she was herself again, she thanked him for his goodness, and said that on the next day she must set out on the journey which she was making when she fell sick. Then for the first time the hunter felt what it was to be lonely; for as he had always lived by himself he had never before missed the company of other people. So he entreated her not to leave him, and the fair stranger, seeing his loneliness and remembering his kindness, stayed with him and became his wife.

Not many days after this the hunter started in the morning to hunt, and called his dogs to go with him; but the fair stranger begged that they might be left at home, to guard her from the white cows. Now, the hunter had never before gone to the woods without them; but she begged so hard that he would leave them with her, that at last he tied them up in the hut, so that they should not follow him, and went forth to hunt alone.

After he had gone some way he heard behind him a great noise, and looking back saw all the white cows in the forest, who had gathered together and were about to tear him to pieces. The hunter was greatly frightened, and ran like the wind for his home. But, fast as he ran, the cows followed faster, and he knew that they would catch him long before he could reach his hut. Then he remembered his three magic arrows, which he always carried with him in his belt, and taking one of them, he stuck it in the ground and put his foot upon the butt. In a moment he felt himself shooting up through the air, and found he was on the top of a tall palm tree which had sprung up out of the ground, and whose smooth trunk no cow could climb.

The fury of the white cows when they saw their victim thus snatched from their grasp was terrible to see. The woods echoed with their cries of rage, and with lowered heads they charged the palm, butting it till it rocked as if in the midst of a tempest. When they saw that they could not overthrow it in this way, they all at once rushed into the midst of the woods, but returned in a few moments bearing sharp axes, with which they began to cut down the tree. Its trunk, however, was strong and tough; but the cows flew at it in a great crowd, and when one was tired another took her place. Great chips flew from the palm, and the hunter as he sat in the tree-top could hear the song of the axes as they bit into the hard wood:

He now became greatly frightened and wished to call his dogs to his aid, hoping that they might hear him and break away, or that his wife might loose them; so he called them loudly by name:



But they did not come, and he feared that they could not hear him. And, while he cried, the cows still swung their axes, which sang yet louder, as though to drown the hunter's voice:

A-phi-bim—Gas-co-ma-bam;
A-phi-bim—Gas-co-ma-bam!

Now the tree began to shake, as it had been almost cut through, and the hunter in great terror cried to his dogs at the top of his voice:

Ya-mo-o-ro, Con-ga-mo-ro-to!
Ya-me-o-ro, Con-ga-mo ro-to!

but all in vain.

Then he took the second of his magic arrows, and, fitting it to his bow, he shot it down into the ground. At once another palm sprang up, taller and stronger than the first, to which the hunter leaped. And he was not a moment too soon; for the tree he had left tottered from its base and fell with a great crash to the ground.

When the white cows saw the second tree, they were very angry, and rushed at it again with their axes, plying stroke on stroke in their rage and fury, while the hunter kept calling his dogs by name:

and the axes rang louder and louder:

Soon the second tree was ready to fall, and the hunter had to shoot his last arrow into the ground, when a palm taller and larger than either of the others sprang up into the air. Now he saw that unless help came quickly his end was near; for he had no more arrows, and above the din of the axes he called as loud as he was able:

Come, Ya-me-o-ro! come, Con-ga-mo ro-to!

Suddenly he saw the fair stranger approaching, and he called to her to help him, and run back and loose the dogs; but she laughed at him, saying that his dogs could not aid him now; and as she spoke she changed into a white cow herself, and the hunter saw that she was the queen of the herd, who had become a woman only to entrap him. Still the axes kept crying:

A-phi-bim—Gas-co-ma-bam;
A-phi-bim—Gas-co-ma-bam!

and the tree was almost cut through. For the last time the hunter called his dogs to come to his help:

Come, Ya-me-o-ro! come, Con-ga-mo-ro-to!

and as he did so he heard a crashing sound in the bushes, and the dogs, who had at last gnawed their ropes apart, made their appearance and sprang upon the white cows.

First they attacked the queen and tore her to pieces, and then, turning upon the rest of the herd, they killed many and put the others to flight, so that the hunter was saved.

Such is the form of the legend as I received it from the gentleman referred to above, whose culture and the position he held in society warrants me in believing him to be an authority on this matter.

He was born in 1805, and must have heard the legend at least as early as 1810. He received it from his negro nurse, a slave, whom his father had bought direct from the coast of Africa. Assuming the woman to be of a responsible age, which she must have been to have had the care of children, it was unquestionably current on the coast of Africa in the latter part of the eighteenth century, and probably for a long antecedent period.

The most unique feature of this tale, and that which made it especially attractive to children, was the hunter's musical call of the dogs, and the song of the axes. The narrator sang these, repeating them many times in the course of the story to a curious refrain which I have attempted to reproduce in the music given above.

This, indeed, was the chief charm of the story, and so well was it executed that one could almost hear the ring of the axes as they rebounded from the tree, while the changes of voice in the cries of the hunter represented his increasing anxiety and fear as time went on and no aid came to him. It is difficult to describe the effect thus produced; to appreciate it, it was necessary to hear it.

Nearly a hundred years later this story was current again in Georgia, where it was made public by the facile pen of Mr. Joel Chandler Harris, better known as the author of the Uncle Remus stories. As will be seen on examination, it has changed considerably, but its principal points remain unaltered. I regret that I can not reproduce Mr. Harris's story in full, but a copyright prevents me from doing more than making a few brief quotations.

This story, which Mr. Harris entitles "The Little Boy and his Dogs," appeared in the Louisville Courier-Journal, February 18, 1886, and is somewhat as follows:

A little boy lives with his mother in a hut beside a road. He is her only child; but Uncle Remus, who tells the story, informs us that the boy once had a little sister, who had been stolen away—how, it is not related—and whom her brother searches the woods in vain to find. One day, while engaged in this pursuit, he meets two ladies wearing long veils, who come to his mother's house and ask for some water, when the following conversation occurs:

"Reckly he holler out, 'Mammy, mammy! what you reckon? Dey'er lapping de water!' De 'oman she holler back, 'I reckon dat's de way de quality folks does, honey.'"

Then the ladies ask for some bread and eat it, so as to cause the little boy to cry:

"Mammy, mammy! what you reckon? Dey'er got great long tushes." De 'oman she holler back, "I reckon all de quality folks has got 'em, honey."

Then they wash their hands, and again the boy cries:

"Mammy, mammy! what you reckon? Dey got little bit er hairy hans and arms." De 'oman she holler back, "I reckon all de quality folks has got 'em, honey."

The ladies now request that the little boy show them the way to the cross-roads, which he refuses to do until admonished by his mother.

"Now," says Uncle Remus, "dish yer little boy had two mighty bad dogs. One un um waz name Minny minny Morack, en de oter one was name Follerlinsko, en de waz so bad dey hatter be tied in de yard day an' night, 'cep w'en dey wuzen't a-huntin'."

Before setting out, however, the boy places a pan of water in the kitchen, and sticks a willow twig near by in the ground, telling his mother that when the water turns to blood and the willow shakes, she is to loose the dogs and send them to hunt for him. He then proceeds to conduct the ladies to the cross-roads; but after he has gone some way perceives, on looking behind him, that the supposed ladies are walking on all fours. This strikes him as somewhat suspicious, and he hastens to climb up a big pine tree near at hand for safety. The ladies try and persuade him to come down, threatening to tell his mother of his disobedience; but in vain; the little boy prefers to remain where he is. "Den," says Uncle Remus, "de quality ladies got mighty mad. Dey walked 'roun' dat tree en fairly snorted. Dey pulled off der bonnets, en der veils, en der dresses, en, lo en behole! de little boy seed dey wuz two great big pant'ers. . . . Dey tried to climb de tree, but dey had done trim der claws so dey could git on gloves, en dey couldn't clam no mo'.

"Den one un em sot down in de road en made a kuse mark in de sand, en der great long tails turned to axes, dan de gun to cut de tree down. . . .

"But wiles the little boy wuz settin' up dar skeered mighty nigh ter def, hit come inter his min' dat he had some eggs in his pocket w'at he done brung with 'im fer ter eat w'enever he git hongry. He tuck out one er de eggs en broke it en say, 'Place fill up,' en bless you soul! de place fill up sho' nuff, en de tree look des 'zackly like nobody ain't bin a-cuttin' on it."

This occurs three times, when, just at the critical moment, as his eggs are all exhausted, his mother sees that the water in the pan has turned to blood and that the willow twig is shaking, so she releases the dogs. The little boy hears them coming, and calls out: "Come on, my good dogs! here, dogs, here!"

The dogs come in the nick of time, and kill the panthers, who are unable to escape, since they have not time to change their axes back into tails. Here the story wanders off to the finding of the small boy's sister, who is rescued from the clutches of "Brer Bar."

There is, I think, no question but that these two stories have a common origin; the resemblance is so strong that it hardly seems necessary to mention it in detail.

The hunter, changed to a little boy in the version of Mr. Harris; who is possessed of two dogs which he rashly leaves at home; who is attacked by wild beasts in human guise who chop with axes the tree into which he climbs to escape them; the miraculous restoration of the trees, and the rescue by the dogs, appear in each narrative.

As I have before stated, nearly a hundred years must have intervened between the telling of the two legends, and the variation in the second is plainly due to the change of scene and of environment which befell the people who preserved and told the story.

It is only the artist who can successfully set a narrative in a scene with which he is not familiar, and make the environment seem real. Folk lore, however, is no artist's tale; it is told by a child of the soil, who unconsciously clothes his narration with the scenes and incidents with which he is best acquainted. The gentleman to whom the story was told in the early part of the century received it from a native African, who had heard it in her own country; while Mr. Harris must have obtained his from a Georgia negro, who had grown up in exile and slavery. The local coloring was, of course, totally different.

The hero in what, if I may be permitted, I shall call the unadulterated version of the story, is a hunter; and this is very natural, for hunting must have been one of the chief occupations among the uncivilized negro tribes of Africa. In Mr. Harris's version he becomes a little boy; but this is perhaps the author's regulation little boy, who figures so often in the "Uncle Remus" stories. In the same way another change, which at first would seem to be due to local environment, can be shown to be produced by other causes. I refer to the substitution in the later story of panthers for white cows. In portions of Africa cows can not exist, and, whether this was the case in the region occupied by the tribe whose legend this was, I am unable to say; but it is certain that at some time or other they must have seen white cows, otherwise they would not have told about them. The panther, on the other hand, is a native of Africa; and, indeed, there are no panthers in our Southern States, unless the name is erroneously applied to the American puma. It is, therefore, quite likely that in the original legend, as it was currently known in Africa, both the cows and the panthers might have figured, since both were known to the people.

A little further examination of the two stories will, however, illustrate strikingly the changes due to locality.

In the first place, take the ladies into which the animals transformed themselves. In Mr. Harris's version they are spoken of as "quality folks," but there were no quality people in a civilized sense in Africa, and in their stead we find a "fair stranger," whom one could well imagine would seem a mysterious being to a lonely African hunter. So, too, we find that the three magic arrows of the first story have changed to three eggs in the second, and a palm to a pine tree, which latter change involves for Mr. Harris an explanation of why the panthers couldn't climb the tree, which was not needed in the first version. Such are some of the local changes which the legend has undergone during the past century. Others could doubtless be found, but I prefer to pass from these to changes of greater significance. Before doing so, however, let me say a word in regard to the names of the dogs. Ya-me-o-ro and Con-ga-mo-ro-to have an Eastern tone that fits exactly with the African legend; but where, within the confines of Georgia, did Mr. Harris unearth such remarkable combinations of letters as "Minny minny Morack" and "Follerlinsko"? Uncle Remus, I am sure, could never have pronounced them, and one is inclined to believe that they were conjured up by the author's fertile brain to take the place of the euphonious forgotten titles.

Though change of locality has much to do with the alterations occurring in folk lore, it is by no means the only factor which brings about such results. Contact with a foreign predominant race, and with its customs and legends, has an equally great effect.

In the first quotation which I made from Mr. Harris's version one of these alterations just noted is to be found. The ladies are discussed, by the little boy and his mother, in regard to their manner of drinking, their hands, and their teeth. Now, this inquiry and thirst after information on the part of the little boy is thoroughly English in spirit. The native African would never have asked such questions, because he was by nature lazy and indifferent. It also suggests very strongly the story of Red Riding Hood, which has almost become a classic in the English tongue. Red Riding Hood, the reader will remember, visits a wolf, disguised as her grandmother; asks him a series of questions somewhat like those just referred to, and beginning, "But what great eyes you have, grandmother!" "The better to see you with, my dear." Indeed, this tendency for inquiry is prominent in most English legends, and I think there is ground at least for the surmise whether Mr. Harris's negro has not unconsciously transplanted into his own legend the characteristics of the legends belonging to the race which he served.

One other factor of moment remains to be noticed, and this, I think, is more important than all, and is due to the change in the national life of the people whose legend it was—i. e., from a state of freedom to one of slavery. One example will suffice, I think, to show plainly what I mean. In the first version of the story, which was originally told by a negro born free, the laws of cause and effect are carefully observed throughout. The hunter is attacked by the white cows because he destroys them, and in his death they recognize their safety. Now, in the second version of the story, which Mr. Harris must have obtained from a Georgia negro whose ancestors from whom he had received the legend had been slaves for three or four generations, there is no logical sequence of events, and an apparent ignorance displayed of the same law of cause and effect. Here the panthers merely appear, and attack the little boy, for no assignable reason whatsoever. It might be argued that their desire for food was a sufficient cause, but it is not the custom of panthers to disguise themselves for the purpose of entrapping their prey. According to the unwritten canons of all legends, these disguises may only be assumed on important occasions. This, however, does not affect the significance of the change. In a free tribe, whose members were dependent on their own unaided efforts for support, the laws of cause and effect would naturally be clearly understood, and a legend which disregarded these would be held in contempt: for these people believed their legends to be true. They must, therefore, of course, conform to the laws of their existence, so that they might possess the semblance of truth. When the story comes to be repeated years after in a state of slavery, and by one who heard it from slaves, the laws of cause and effect are disregarded, and very naturally; for why should the negro trouble himself about such matters, when food and clothing were provided for him by his master, and he was looked after in his old age?

Another alteration due to this change may be noted in the difference of the persons of the actors already mentioned. In Africa, it was a national legend, and the hero was accordingly a man; in Georgia, the heroic period of the race had passed away, and the legend had degenerated into a story told to please a child, and in which a child held the prominent part.

There is one more very curious point in regard to the treatment of the hunter by the woman, which has an ethical significance which seems more than national. The woman, after entrapping the hunter by her charms and depriving him of his strength in the shape of the dogs, surrenders him to his enemies.

Between the Aryan and negro races there is a very great difference—the difference between a race that has a written language and one that has not. It would seem that their religions might have little or nothing in common: yet in this legend of the woman and the hunter have we not a counterpart of the legend of Samson and Delilah, in the Bible, where the woman, having deprived him of his strength, gives him over to his enemies?

Thus we see that among all races it has been customary to incorporate cardinal virtues and cardinal vices in legendary form, and it is only too likely that Delilahs existed on the coast of Africa as well as elsewhere: and, alas! as men daily learn, are still among us.

Such are some of the changes in an example of folk lore which a century has wrought: but they are not greater than the changes which the people whose folk lore it is have undergone, and which, as I think I have shown, in no uncertain manner.

The legend, we might almost say, is the gauge of a people, for it clearly shows the risings and fallings in its social and mental condition. It is interesting to note how the one noted has remained intact in its general outlines, in spite of the disintegration of the tribe with whom it probably originated. Folk lore is one of the few immortal possessions of a nation. Its greatness may fade, and its name be forgotten among men, but while the world exists its national legends will still remain. Thus, out of the ignorance of a people, may be built their only monument of lasting fame.

ANTHROPOLOGICAL WORK IN EUROPE.

By Prof. FREDERICK STARR.

WITHOUT visiting either Stockholm, Vienna, or Rome, the author has recently seen many of the museums of ethnography in western Europe. It has seemed to him that a sketch of the workers and a description of the work in anthropology there might be of interest to readers of the Monthly. Hence this article, which makes no claim to exhaustiveness, but which does aim to suggest something of the intense interest now shown in that science in Holland, Germany, Switzerland, Italy, France, and England. Under the comprehensive word anthropology we comprise physical anthropology, ethnography, prehistoric archæology, and culture history.

Museums of ethnography are far more common in Europe than with us. There are, perhaps, no large cities without such an institution, and many small towns have fine collections. In the little kingdom of Holland alone there are fully a half-dozen ethnographic museums of importance, the chief one being at Leyden. This city is the main educational town of Holland, and its university, always famous for its corps of teachers, still holds its rank as a finely manned institution of learning. Besides the university, the town boasts of one of the best museums of antiquities in the world, particularly rich in Egyptian and Javanese objects, and the ethnographic museum, which in some respects is unsurpassed. Like many of the great collections in Europe, the latter is unfortunate in its housing. The part usually shown to visitors comprises the wonderfully rich collections from the South seas and the East Indies. These are in exceedingly crowded and ill-lighted quarters, and a satisfactory display is impossible in the present building. The African collections are in a second building as little suited to display as the first, and the rich series from Asia are stored in yet a third building. It is much to be desired that this collection might be brought together under one roof in a building of suitable character and well lighted and suitably cased. We have already referred to the wonderful series of objects from the South seas and the Indies. Many of them, brought home by the early navigators, are old, and represent the native arts before they were affected by white influence. Especially fine are the carved work, weapons, armor, and articles of dress and adornment. New Guinea is finely represented by objects from different parts, well illustrating the local variation in arts. The specimens from Sumatra, Engano, Nias, Borneo, and Java illustrate the whole life of the natives. The collection of *krises*, or dirks, is probably the largest in the world, and many of the specimens are masterpieces of metal-work, and the hilts and sheaths are crusted with precious stones. Dr. Serrurier, the

Dr. J. D. E. Schmeltz.

director of the museum, classifies ethnographic objects into twelve groups—such as relate to—(1) Food, Drink, etc.; (2) Clothing; (3) House-furnishing; (4) Fishing and Hunting; (5) Agriculture; (6) Domestication of Animals; (7) Trading; (8) Manufactures; (9) Weapons and War; (10) Government and Society; (11) Toys, Music, Theatre, etc.; (12) Religion, Science, and the like. This scheme of classification runs through the whole arrangement of the museum. Dr. Serrurier is fortunate in having associated with him as conservator Dr. J. D. E. Schmeltz.

There are in the university faculty several men who, without being professional anthropologists, have more or less directly done work of importance to anthropological science. Such are the famous Sanskrit scholar, Prof. Kern; the Sinologue, Prof. Schlegel, and Dr. Thiele, of the theological school. The latter has contributed much to the present scientific study of religions. Prof. Schlegel's Chinese Dictionary is far more than a "word-book," and is a treasury of ethnological material to which all students must refer. With M. Henri Cordier, of Paris, Prof. Schlegel is editor of an interesting bimonthly journal devoted to Asiatic subjects—Toung Pao. The university has a chair of Ethnology, which was for several years ably filled by Prof. George Wilken, whose death a few months since was a serious loss to the institution. Prof. J. J. M. de Groot has been appointed to the position.

Dr. Rudolf Virchow.

Prof. Kern and Prof. Schlegel, with other workers in ethnography in various countries, form an editorial committee of the Internationales Archiv für Ethnographie, a journal appearing at Leyden under the very capable direction of Dr. J. D. E. Schmeltz. Dr. Schmeltz is a rare worker. Born in Hamburg, his first important work in the field of ethnography was done upon the famous Godeffroy collection from the South seas. The result of his work was the well-known illustrated catalogue of that collection, which is the first work that the student of the South-sea cultures must know. Dr. Schmeltz has been Conservator of the Ethnographic Museum at Leyden for more than ten years. When the Archiv für Ethnographie was established, a little more than four years ago, he was intrusted with its management. The journal is a quarto in form, appearing once in two months, and the articles, which are always of great value, are in French, Dutch, German, and English. Every number is illustrated, and many of the plates are handsomely colored. We have laid considerable stress upon this journal because of its great value, and because it is far too little known in this country.

We have let Leyden stand as the type of work done in Holland, but it is not the only center. Considerable ethnographic museums, with good workers, are located at Rotterdam, Haarlem, The Hague, and Amsterdam.

Germany is full of workers in every line of anthropological study. To describe what is done at Leipsic, Halle, Berlin, Dresden, Munich, Heidelberg, and Freiburg will give some idea of the aims and methods of the work. And first we will consider the work in physical anthropology. At Leipsic we find Dr. Emil Schmidt, extraordinary professor at the university. He offers in three successive years three courses of lectures to the students—general ethnology, prehistoric archæology, and physical anthropology. Dr. Schmidt is a critical and careful worker, and, notwithstanding the profound abyss separating German and French workers, he is well spoken of in France. His little book, An thropologische Methoden, is the best hand-book for the student in the laboratory or the field that is accessible. Although a man past middle life, Dr. Schmidt is an active worker, and he has just returned from a trip to India and Ceylon, where he did extensive field work. In his laboratory he has a private collection of over a thousand skulls, many of them of his own gathering. Dr. Schmidt is ingenious in suggesting new methods of work and study. He is the originator of the *cranial*

PROF. JOHANNES RANKE.

modulus. One of the chief objects of study in physical anthropology is the skull, and it is important to have some convenient means of comparing skulls of different kinds. To compare measurements taken in one direction only, of course gives no results of value; thus, to know that one skull is nine and another is eight inches long, tells nothing as to shape or relative capacity. Authors accordingly devised the *cranial index*, found by dividing the length of the skull into the breadth and expressing the result decimally. If skulls had but two dimensions this index would be satisfactory; as it is, it is not perfect. A new index was devised which should take account of the height of the skull; the height being divided by the length and the result expressed decimally. By a combination of these two indices a fair idea of the skull would be given, but in a comparison of the indices of a number of skulls great difficulty arises. One expression is what is desired. After much careful study and experimental work, Prof. Schmidt worked out the modulus; the length, breadth, and height are measured and their arithmetical mean is taken.

A veteran worker is Dr. Herman Welcker, Director of the Anatomical Laboratory of the University of Halle. The building he occupies is one of the few in Europe that has been built recently and for scientific purposes. Welcker's work extends back through many years, and, although all of his suggestions have not been accepted by other workers, his contributions to craniology have been numerous and valuable. In the museum under his charge is a wonderful series of skulls, especially rich in Papuan, South sea island, and Indian specimens. One noticeable feature of the museum is the exceedingly large collection of human monsters, two-headed, cyclopean, etc.—perhaps the largest in the world.

No physical anthropologist in Europe is more widely known or more respected than Dr. Rudolph Virchow, of Berlin. He is in charge of the Pathological Institute of the university, where he has a vast quantity of valuable material. Among other osteological collections are great numbers of skeletons and skulls of the Negrito pygmies. Virchow's writings have been extensive and most important. He is at present engaged upon a great work—a study of crania of American Indians, from both the Northern and Southern continents. An atlas of plates will form a part of the work, and every skull will be represented as seen from five different positions. The matter of fixing a skull in position for drawing is one of no little importance, and unfortunately there is no agreement between French and German workers in regard to what shall be called the horizontal line. The French consider a line drawn from the occipital foramen to a point between the bases of the upper middle incisors as horizontal, while the Germans make it pass from the middle point of the upper curve of the auditory meatus to the middle part of the lower curve of the optic orbit. Virchow claims that the German line is preferable, as it can easily be taken on the living person, as well as upon the skull. He adds, usually with a little quiet satisfaction: "The French horizontal line throws the head up, while ours throws it more naturally and downward; they are more proud, we are modest." For years Dr. Virchow has edited the Zeitschrift für Ethnologie, the official journal of the Berlin Anthropological Society, of which he has always been a leading member. Dr. Virchow's seventieth birthday was celebrated with much of German heartiness last fall, but years tell little on him, and he does a prodigious amount of work with all the enthusiasm of a young man.

Of the many other workers in physical anthropology in Germany we can mention but one—Dr. Johannes Ranke, of the University of Munich. He is perhaps the only full and regular Professor of Physical Anthropology in Germany. Since 1866 Prof. Ranke has been editor of the Archiv für Anthropologie, and since 1877 of the Urgeschichte Bayerns. His work, Der Mensch, in two large volumes, is the best elementary work on descriptive anthropology. His laboratory is well equipped—in part with instruments of his own devising. One of the most important operations in anthropology is finding the internal capacity of the cranium. There are a host of methods. The difficulty is that no two methods give the same result, and no single method in the hands of two unskilled observers gives exact agreement. The thing desired, then, is to work out a method of "cubage" that shall give invariable results. Dr. Ranke has attempted this. His students are given a bronze skull of known capacity. This is filled with millet seed rammed in tightly with a wooden plug. The filling is afterward turned out and measured. Every step in the operation is subject to fixed rules. When a student gains such skill that he succeeds

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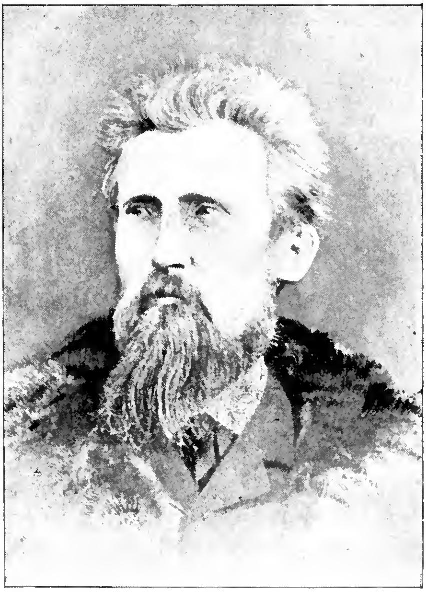
always in getting the capacity of this standard skull exactly, he is considered competent to measure the capacity of real crania. In drawing skulls most German workers use an instrument called a diopter, which produces a drawing of the natural size. Dr. Ranke has ingeniously attached a pantograph to the diopter in such a way that a correct reduced drawing may be produced at one operation. His craniophore—an instrument for supporting a skull in a horizontal position for purposes of study—is the simplest and best made, but is, of course, suited only to the *German* horizontal.

Prof. Ad. Bastian.

In German Switzerland, at Basel, is Dr. Kollman, best considered here, as he is of the German school. Prof. Kollman is a born teacher, and every specimen in his Anatomical Museum of the university is considered as instruction material, and is so mounted or prepared as to make its teaching value the greatest. The subject of prehistoric races has taken much of his attention, and a large case in the museum is devoted to a series of casts or originals of such skulls. Particularly interesting is the large series of prehistoric Swiss skulls representing the types described in His and Rutimeyer's classic work. Dr. Kollman has introduced some exceedingly long and difficult words into the nomenclature of physical anthropology—leptoprosopic, chæmæprosopic, etc. They are descriptive of cranial forms, and are intended as classificatory; it is doubtful, however, whether they really express natural types or simply artificial and arbitrary groupings.

As to ethnography, Germany is permeated with it. Magnificent collections are numerous, and workers are everywhere. Leipsic is a center of work. Here is the collection at which Dr. Klemm worked so diligently, now in charge of Dr. Obst. Only a small part of the treasures of this collection are on display. These are crowded, poorly arranged, and badly lighted; and a vast quantity of precious things are stored away, where they must be deteriorating in value as the months pass. In the university is Prof. Friedrich Ratzel, best known to us for his Volkerkünde —an introduction to ethnography. Dr. Ratzel is now revising this work, and he has lately issued a yet more valuable treatise —Anthropogeographie. Ethnography is most interesting to him in its geography, and he at present lays especial stress upon the local distribution of customs and arts. Prof. Ratzel is a favorite teacher, and has sent out many young men imbued with his methods. Among these, one of the most promising is Dr. Heinrich Schurtz, privat-docent at the university, whose recent Philosophie der Tracht is an application of Ratzel's methods to the study of dress.

Drs. Meyer, Lueders, and Buchner are doing fine work with the museums at Dresden, Hamburg, and Munich, and deserve more than a brief reference. But the ethnographic work of Germany and of the world culminates in Berlin. Adolph Bastian is the director of the museum, the leader of the corps of able workers who carry it on. He is a man whom years do not make old; one who has unquenchable fire and enthusiasm. He is decidedly the right man in the right place. The Government has been liberal to him, but he continually needs new funds for more and greater enterprises. No one recognizes more clearly than he the importance of doing ethnographical work *now;* to-morrow will be too late. Old tribes are dying out; new customs are being introduced; native cultures are being swept away, or rapidly modified by contact with the civilization of the white man. Illustrations of such cultures must be saved now or never. "It is a burning house, and the main purpose is to gather material for the future to use. And contents are lost while we wait." So his prodigious accumulations are here—for example, Dr. Grunwedel, who has direction of the India collections, has upward of twenty-four thousand objects in his charge. Prof. Bastian is a great traveler and a busy writer. Scarcely a year passes without an important work from his pen.



Dr. Eduard Seler.

The American department of this vast collection is exceedingly valuable. There is but little from the Indians of the United States; from ancient Mexico and Peru, from the modern South American tribes, and from the Northwest coast the representation is magnificent. The culture of Eskimos, of Tlingits, Haidas, and Bilgulas are fully shown. Some very choice Mexican antiquities collected by Humboldt are here. Here, too, are three of the exceedingly rare and interesting mosaics from Mexico made by overlaying forms of wood with bits of turquoise, obsidian, and shell. Perhaps a score such are known in European museums: seven are at London, three at Berlin, two at Copenhagen, and five at Rome. They are among the most curious and interesting Aztec objects. There are fine series of pottery from Mexico and Yucatan. The collection of Peruvian pottery is wonderfully complete, and is no doubt the finest on public display in the world. Reiss and Stubel's great collections, upon which their famous work, The Necropolis of Ancon, is based, are here, and include the finest general series of Peruvian antiquities on exhibition—especially rich in wrapped mummies, fine cloths, and household goods. As for modern ethnography, there are series of objects from almost every tribe from the Caribbean Sea to Cape Horn. All this wealth of materials is under the care of Dr. Edward Seler, whose special work upon Mexican subjects has made him known to Americanists.

The men at Berlin are all hard workers. Dr. F. von Luschan, curator of the African department, exemplifies this. Himself a specialist in biblical archæology, and frequently in the field overseeing excavation, he allows no opportunity to pass unimproved for gathering anthropological material of every kind. In addition to his regular work he has, while in the field, taken photographs and anthropological measurements of more than three thousand persons, some of them among barbarous and little-known tribes—a work which alone would not represent an idle life.

We can refer to but two more of the German workers—Dr. Richard Andree and Dr. E. Grosse. Richard Andree, of Heidelberg, has the heartiest admiration for our American ethnographers and their work, and it is certain that they reciprocate. His writings are always clear and direct. His latest work perhaps is his Ethnographische Parallelen—a good example of his style and ability. As editor of the geographic journal Globus, Dr. Andree is known the world around. At the old University of Freiburg, in the most picturesque part of the Rhine mountain country, is in progress one of the most hopeful works in anthropology in Europe. Dr. E. Grosse is there developing a museum and a department of anthropology. No effort is made to collect a great mass of material, but carefully selected specimens are arranged so as to show man's progress from the oldest age of stone to the present time, and so as to present pictures of life in various existing tribes of savage or barbarous men. Nothing is here done in physical anthropology, but lectures are given in ethnography and culture history, and these are exceedingly popular. Dr. Grosse's work is unobtrusive, but it is sure to be far-reaching.

Much of the value of collections is lost by bad arrangement. Nowhere is there such pains taken in display as at Copenhagen. The results are beautiful, although nowhere have greater disadvantages had to be overcome. The Ethnographical Museum is the oldest in existence, having been founded in 1847 Inspector Steinhauer, now seventy-five years of age, has had the arrangement in charge. Dr. Kristian Bahnson, a specialist in American ethnography, is his assistant. To Inspector Steinhauer was given an old palace, with many small rooms, not at all adapted to the housing of a great museum. He has done wonders; not an inch of space is lost, and great ingenuity is displayed in making available what must at first have looked like useless wall-room and passage-ways. The collections are arranged first by countries or tribes, and the material from any one region is rigidly classified into groups: (1) Religion; (2) Men; (3) War; (4) House; (5) Industry and Art; (6) Amusement. Within the cases themselves the objects are arranged with the greatest care so as to produce the most pleasing effect possible. In the same building is the Museum of Northern Antiquities, under charge of Dr. Sophus Müller. Denmark is classic ground for the prehistoric archæologist. Scarcely a foot of its surface but what has yielded relics. Its peat-bogs, kitchen-middens, and tumuli are famous. Here are found the finest flint-chipping in the world, the most interesting of bronze implements, the finest gold ornaments of the bronze age, and vast quantities of specimens illustrating the early age of iron. No student can afford to neglect this collection. The Museum of Northern Antiquities is exceedingly popular with the


Dr. Richard Andree.

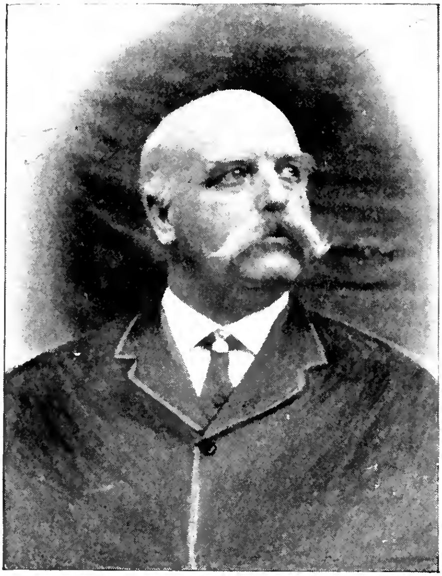
Danish people, who are very loyal in sending to it specimens they may find. The Government itself is very wide awake to the importance of such work as is here done, and has acted vigorously in the matter of preserving tumuli and other monuments of the past.

Anthropology is by no means neglected in Switzerland. With men like Vogt and Kollman in physical anthropology, with museums of ethnography at Basel, Bern, and Zurich, it is still true that the department of prehistoric archæology leads the rest there. This is quite natural, for every lake has its old village sites and every town of consequence has its collection of "lake-dwelling" antiquities. There are more than two score such, of some importance, in Switzerland. Certainly those at Bern and Zurich may be taken as good examples. The former, under Dr. van Fellenberg, represents very fully all three of the great "ages" of the archæologist. The oldest lake-dwelling villages of Europe date back to the age of stone (the neolithic period); many were of the bronze age; some were of the early part of the age of iron. Some of the sites were occupied continuously from the older to the later time, while others represent only a single period. At Zurich are the collections upon which Dr. Keller's work was based, and very much valuable and interesting material from recent explorations undertaken quite near the city. Dr. Heierli, who teaches prehistoric archæology in the University of Zurich, has still a largely unworked field in Lake Zurich. It is a mistake to think of the lake-dwelling sites as "worked out."

Prof. Paolo Mantegazza.

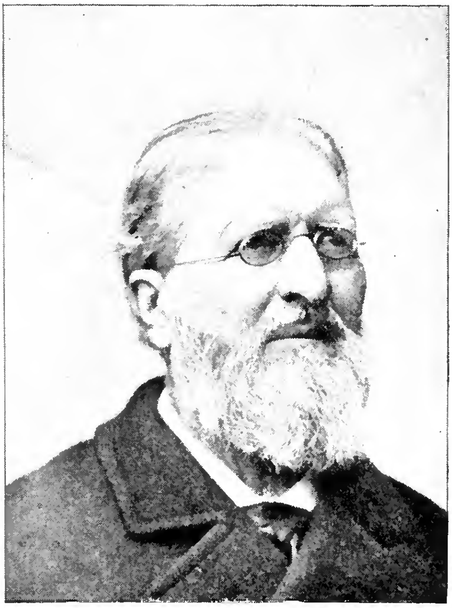
Italy is very active in anthropological work. At Turin Prof. Guido Cora conducts a geographical journal which contains much ethnographic matter; in the same city Prof. Lombroso experiments, writes books, and edits a journal, to which is due much of the present interest in criminal anthropology. In Florence are Mantegazza, Giglioli, and Regalia. At Perugia, Belluchi works away at the stone age of Italy. In Rome is one of the great ethnographic museums of the world, with Pigorini as director and Coligni as assistant. Two of these workers occupy unique positions. Prof. Paolo Mantegazza is President of the Anthropological Society of Italy, editor of an anthropological journal, Director of the National Museum of Ethnography and Anthropology, and professor in the university. We mention these titles because they suggest his work. Physical anthropology, man himself, is his specialty. Mantegazza has traveled much and has written works of value as a result—such are his monograph upon the Lapps and his work on India. But the books to which his fame is most due are of a more general character. Such are his Physiology of Pleasure, Physiology of Pain, and Physiognomy and Expression. The latter has been published in America in English, and will give a good idea of his style. His trilogy on love—Physiology of Love, Hygiene of Love, and Ethnography of Love—has created a sensation. The German translation of these has sold by tens of thousands; a similar success has attended the French edition; and in Italy they are seen everywhere. Mantegazza's mind is intensely analytic. This is shown both in his writings and in his museum. Nowhere else, so far as we know, is analysis applied to anthropological material. He divides it into groups illustrating: (1) Comparative anthropology, (2) biological anthropology, (3) artificial deformations, (4) pathological anthropology, (5) psychological anthropology, (6) ethnical anthropology. It must be confessed that having divided his material in this way he makes no attempt to arrange it afterward in the cases. In this museum, Prof. Mantegazza has upward of four thousand skulls, two thousand of which are Italian. One of Mantegazza's latest ideas is a psychological museum, in which, by objects, the workings of the mind are to be illustrated. This museum has been begun, but it will be long before the plan can be fully developed. By profession Henry H. Giglioli is a zoölogist. In charge of the department of vertebrate zoölogy at the University of Florence, his work in that line speaks for itself. Interested in ethnography by a voyage he made around the world, he has gathered a collection of stone implements unsurpassed perhaps by any other private collection. The idea of the series is not to illustrate the stone age of any one place or people, but by carefully selected specimens from every part of the world to show all types of stone implements. Prof. Giglioli has also much interest in the persistence of the use of stone tools into later culture stages.

Paris epitomizes France, and certainly the character of French work in anthropology is fairly shown if that of the capital is described. Anthropology is more cultivated in Paris than anywhere else in the world, and every department is there developed. The ethnographic collections are at the Louvre, the Trocadéro, and the Musée Guimet. It is a pity that the material from Africa and the South seas now at the Louvre is not sent to the Trocadéro and incorporated in the collections there under charge of Dr. Hamy. The Trocadéro is a beautiful building, and the collections it contains are of great importance, but it is not adapted to their suitable display. Dr. Hamy has made the best of his circumstances, and his cases and wall trophies (usually an abomination in a museum, but here a necessity) are true works of art. The hall devoted to African specimens is wonderfully fine, and the collections from South America, Mexico, and Yucatan are quite as good as any in Europe. One feature of this museum is that it contains a fair representation of the ethnography of Europe—a thing exceedingly rare. The Musée Guimet embodies a brilliant idea, the illustration of the world's religions. It grew out of an expedition sent to Asia to study the religions of Japan and India. The collections belong to the state and occupy a building constructed for the purpose and beautifully arranged. The display halls are erected about a triangular court, and the two in front are connected by a rotunda. This contains a valuable library composed entirely of works devoted to religions. So far only Buddhism is represented with any degree of fullness. The arrangement is geographical. The religions of India, southeastern Asia, and China occupy the first floor of one gallery, while in the upper floor are objects illustrating the worships of ancient Greece and Rome. In a second wing are the Japanese series on the first floor and religious objects from ancient Egypt on the second. The third hall is as yet largely unoccupied. The chief criticism that one might make of this museum is, that the specimens are all choice pieces; there is little to show the common idols or the mode in which worship is conducted. On the walls in the galleries and the rotunda are many paintings by Félix Regamy representing sacred places, temples, and religious ceremonies.



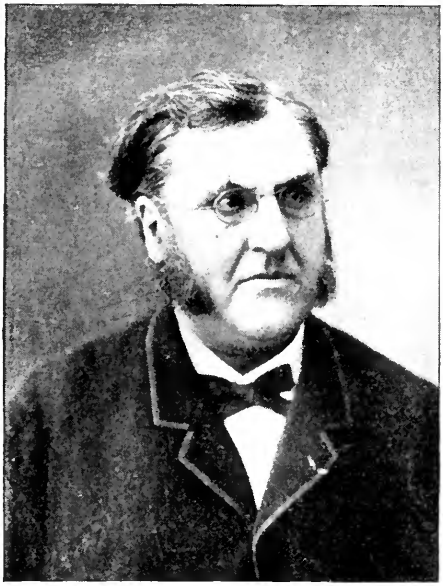
Prof. Henry H. Giglioli.

In America no French anthropologist is so well known as A. de Quatrefages, whose Human Species and Natural History of Man are here widely read. Up to the very date of his death, early in the present year, the old man lived among his books and kept at work, although he was in his eighty-second year. A zoölogist by training, he was one of the few prominent workers in that field who held out against Darwinism and other forms of transformist doctrine. His writings have been of the greatest importance. With his assistant naturalist, Dr. Hamy, he wrote Crania Ethnica, a standard work on the characteristics of race as shown in skulls. His Migration of the Polynesians, Fossil and Savage Men, and the Pygmies, are others of his works that are well known. De Quatrefages was officially connected with the Museum of Natural History, and under his directorship much of the material in the Galerie d'Anthropologie was gathered, and the Laboratory of Anthropology of the museum, perhaps the best equipped and most convenient in the world, was established. This laboratory is situated near the house where De Quatrefages lived (which was, by the way, the home of Buffon). It contains office-rooms for the corps of workers, Doctors Hamy, Vernéau, and Delisle. Two large rooms are supplied with tables, instruments, and materials for the use of students. An excellent dark room for photographic work, rooms for preparation of material, for modeling and casting in plaster, are all provided. A fair library for reference is also connected with the laboratory. The Galerie d'Anthropologie of the museum contains a vast quantity of varied and interesting material, probably the greatest collection in the world. Thirteen rooms are too small for its suitable display. Over two thousand skulls belonging to the collection are packed away for lack of space for them in the cases. One of the rooms is devoted to *fossil men*, and here are many original pieces of great value and world-famous, such as the Cro-Magnon skulls and the Mentone skeleton.



PROF. G. DE MORTILLET.

Besides the work at the museum, there is at Paris a very broad work centering at the School of Medicine. This work is carried on through three distinct agencies, the society, the school, and the museum and laboratory. The *Société d'Anthropologie de Paris* was founded May 19, 1859, by Paul Broca and a handful of other interested men. It is the oldest existing anthropological society, and perhaps the largest. Always aggressive, it has done much to develop anthropological study throughout the world. During his lifetime Broca continued to be a power in its work, and his influence largely trained a body of younger men to take his place. The society publishes its Bulletin, and has accumulated a library of some eight thousand volumes. The *School of Anthropology* is an outgrowth of the society. At first an individual enterprise, it was "recognized of public utility," March 23, 1889, and now receives support from the Government. This season lectures were given on various subjects, more or less directly included under the name anthropology, by twelve professors. The schedule is here copied:



Dr. Paul Topinard.

Monday, 4 P. M., G. de Mortillet: Prehistoric Anthropology. 5 P. M., Mathias Duval: Anthropogeny and Embryology.

Tuesday, 3 P. M., Fr. Schrader: Geographic Anthropology. 4 P. M., André Lefevre: Ethnography and Linguistics. 5 P. M., Georges Hervé: Ethnology.

Wednesday, 4 P. M., J. V. Laborde: Biological Anthropology. 5 P. M., Mahoudeau: Zoölogical Anthropology.

Friday, 3 P. M., Fauvelle: Conferences. 4 P. M., Bordier: Medical Geography. 5 P. M., L. Manouvrier: Physiological Anthropology.

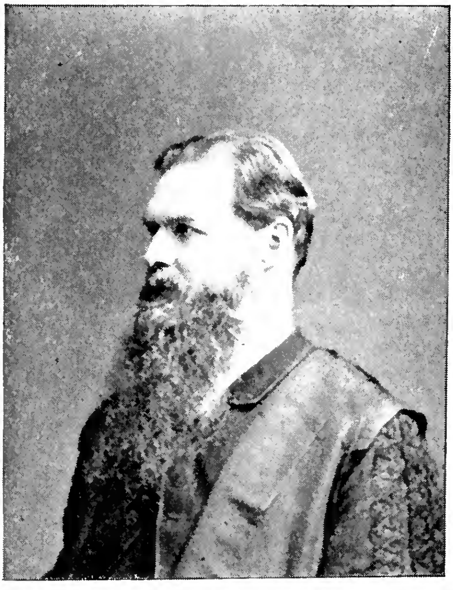
Saturday, 4 P. M., Ch. Letourneau: Sociology. 5 P. M., A. de Mortillet: Comparative Ethnography.

All these courses are absolutely free to the public, and an average attendance of some two hundred persons shows that they are appreciated. The *Museum and Laboratory of Broca* is the third agency of this work at the buildings of the School of Medicine. During his lifetime, under the directorship of Broca himself, and since then usually under Dr. Paul Topinard, they are very largely the work of these two men. The laboratory contains a full series of all instruments that have been made for anthropological investigation, and the material in the museum practically illustrates the whole history of such work in France.

The Professors de Mortillet are father and son, and they have been connected with all the work on prehistorics that France has done. Gabriel de Mortillet has brought order out of chaos, system out of confusion, by his terminology of prehistoric chronology. His system is accepted very widely throughout western Europe. It is somewhat the fashion in America to decry it, but we believe that the nomenclature will become more and more fixed. It will not probably fit our American conditions, but for France and its neighbors it apparently expresses facts. G. de Mortillet's little book, Le Préhistorique, is a model of compact statement and sound criticism. The larger work, the Musée Préhistorique, is the result of joint labor of father and son, and is based upon the unrivaled collections from drift gravels and caverns of France, which they have so beautifully arranged at the museum at St. Germain. Prof. Adrien de Mortillet is a skillful artist, and his lectures are always illustrated with rapidly drawn crayon sketches.

A sketch of French work that omitted Dr. Paul Topinard would be very faulty. An old pupil and friend of Broca, he has done much to carry out his master's work. No one, save Broca, has done more to direct French work in anthropology. In many ways his influence has been felt as teacher in the school, as Director of the Broca Laboratory, as editor of the Revue d'Anthropologie in the past, and of L'Anthropologie at present. Some years ago his little book, L'Anthropologie, an introduction to physical anthropology, caused a real sensation and gained deserved recognition. Later, a much larger work, Éléments d'Anthropologie Générale, appeared, a most valuable manual for the laboratory and for students. Within a few months he has brought out a new book upon the relation of man to the animal world.

In England there is considerable work in progress, though not so much as we might expect when we remember that it was there that Lubbock's works and the famous books of Tylor, Spencer, and Maine appeared. The British Museum has some rich collections in ethnography and prehistoric archæology. The department is in charge of Mr. A. W. Franks and Mr. Charles Reade. The best cataloguing in Europe is done here. Every specimen is numbered. The number, together with a description and history of the specimen, a carefully made pen-and-ink drawing, and references to literature, are all entered upon a large card. These cards are afterward arranged and cared for as usual in card catalogues. We can hardly refer even to some of the more interesting specimens. Magnificent series from the South seas, from Australia, and New Guinea are here. Many objects are of especial interest as having been collected in Captain Cook's voyages. These are not simply interesting as mementoes of the great traveler, but because they present us results of the native industries unaffected by white contact. It is curious to notice how widely scattered Cook's specimens are. Many are here at London, others are at Berlin, Bern, Florence, Leyden, Oxford, and *Australia!* Of American objects the British Museum has some of extraordinary interest: seven of the Mexican mosaics; choice things from Peru; a good Central American and Antillean series, and a fine lot of old Eskimo objects. The anthropological material at the Royal College of Surgeons is extensive and very valuable.



Prof. E. B. Tylor.

In one of the buildings of the South Kensington Museum is Mr. Francis Galton's anthropometric laboratory. Mr. Galton is President of the British Anthropological Society, and the author of various important works upon Heredity, African Peoples, and Human Faculty. He is extremely ingenious in devising apparatus and experiments for determining the degree of development of various faculties. In this laboratory any visitor may be examined and measured free of charge. The examination includes, besides the regular anthropological measurements, tests of eyesight, hearing, color-sense, quickness of muscular blow, etc. The results of the examination are fully recorded on blanks prepared for the purpose, a copy of the record being given to the subject. Many thousands of persons have been measured in this laboratory, and the public has thus been made acquainted with the subject of anthropometry. Mr. Galton is now much interested in studying means of personal identification, and is studying finger-tip impressions as identification material. All at present measured in the laboratory leave their finger-tip marks behind them.

Americans are particularly interested in the little Blackmore Museum at Salisbury, although at present it cuts no great figure in anthropological work. There is here a good building with fair collections of prehistorics and some ethnographical specimens. The bulk of the collections made by Squier and Davis in their exploration of American mounds, and described in their famous work, the Ancient Monuments of the Mississippi Valley, is here. This collection includes a larger number of stone pipes of the "mound-builder type" than any American collection. There are also good things from Central America and Peru. In addition to the specimens, there are in this building a great series of photographs of American Indians and a wonderful library of Americana. The story of William Blackmore's life is almost a romance, and this little American museum in the quaint old English town is one of the strangest of strange things. Would that funds and workers might be supplied to make it felt as a power in the study of American anthropology!

Both of the great universities are at work. Oxford owns the Pitt Rivers Museum, unique in conception. The collection is due to the initiative of Colonel Lane Fox (General Pitt Rivers), and has grown and developed under his guidance and that of Prof. E. B. Tylor and Mr. Henry Balfour. The objects of the museum are set forth in the following announcement, which is posted in various places:

"The specimens, ethnological and prehistoric, are arranged with a view to *demonstrate* either actually or hypothetically the development and continuity of the material arts from the simpler to the more complex forms; to *explain* the conservatism of lower and barbarous races and the pertinacity with which they retain their ancient types of art; to *show* the variations by means of which progress has been affected and the application of varieties to distinct uses; to *exhibit* survivals or vestiges of ancient forms which have been retained through natural selection in the more advanced stages of arts and reversions to such types; to *illustrate* the arts of prehistoric times as far as practicable by those of existing savages in corresponding stages of civilization; to *assist* the question of the monogenesis or polygenesis of certain arts—whether they are exotic or indigenous in the country where they are now found; and, finally, to *aid* in the solution of the problem whether man has arisen from the condition of the brutes or fallen from a high stage of perfection. To these ends objects of the same class from different countries have been brought together, but in each class the variations from the same locality are placed side by side, and the geographical distribution of the various arts is shown by distribution maps. Special finds serving to illustrate the correlation of the arts or of forms have been kept together. The collection was begun in the year 1851, and has accumulated gradually." Only a few of the series displayed can be mentioned—the gun, from the matchlock up to the present (this is the series, the working out of which by Colonel Lane Fox led to the founding of the museum); origin of geometrical patterns; development of forms and ornament in pottery; from the parry-stick to the shield; dress development; fire-making devices; etc. The museum has grown to large proportions, and Mr. Balfour, the able curator, is now overhauling and rearranging the whole. Prof. Edward B. Tylor, who reads courses of lectures upon the History of Culture to Oxford students each year, has exerted a vast influence upon anthropology, not only in Great Britain and America, but also throughout Europe. His great works, Early History of Mankind and Primitive Culture, and his remarkable little Anthropology, have been to many workers their first inspiration.

At Cambridge anthropological work is more recent than at Oxford, but it is now on a good basis and must prosper under Baron Anatole von Hügel. The collections are in part prehistoric, in part ethnographic. There is a very good local series of prehistorics, some of the latest additions coming from excavations in the immediate neighborhood of Cambridge—almost on the very grounds of the university. The chief ethnographic treasures are the collections from Fiji, gathered by Baron von Hügel himself, which are unequaled.

We have aimed in this brief sketch to show where work in our subject is done in Europe, to mention a few of the workers, and to point out something of their methods and plans.

The Canadian Government is trying experiments on an extensive scale in the cultivation of trees. At the Central Farm, near Ottawa, the seeds of Rocky Mountain and European conifers have been liberally sown; and in 1891 one hundred and seventy-five thousand seedlings were transplanted from the beds, to be distributed later on to branch farms and private experimenters, who are to send in careful reports of progress. The Government also distributed one hundred thousand forest-tree seedlings among one thousand applicants in the Northwest, with instructions for planting and subsequent treatment. Twenty-five gardens along the main line of the Canadian Pacific Railway have been supplied from the experimental farms. Speaking of the need of the application of forestry in the old provinces, Mr. J. C. Chapais mentions whole regions as known to him which were cleared by settlers who had to desert the land soon afterward because it was worth nothing. Such districts, he adds, would have been so many inexhaustible wood-reserves for future generations, but are to-day useless.

WHY WE SHOULD TEACH GEOLOGY.

By Prof. ALPHEUS S. PACKARD.

APROPOS of a recent article in The Popular Science Monthly, entitled "Do we teach Geology?" it may be said that, while the science may be taught in some high schools and smaller colleges in the one-sided and perfunctory manner stated, the statements under this head seem somewhat sweeping, as is also the writer's condemnation of all of our text-books; those of Dana, of Le Conte, or Geikie, being comprehensive and excellent. The subject should be taught in our universities and larger colleges, so as to train good teachers in the best field and laboratory methods, who should follow such methods when called to teach in the high schools and smaller colleges. Undoubtedly the best way to teach geology is by lectures, supplemented by text-book study, and the collateral reading of monographs, but especially by required field work, and, when mineralogy and lithology are included, by laboratory work. The teacher should have traveled widely, and seen for himself volcanoes and geysers; should have climbed mountain-peaks, visited cañons, and examined the effects of erosion, and the every-day work of streams, of waves, tides, and ocean currents. He should show his class by what agencies the scenery at home has been produced, how certain mountains have been carved out of blocks of sedimentary rocks, and, if he lives in a region of fossiliferous rocks, the student should be taught to collect and identify fossils.

All this is done with more or less thoroughness in our better equipped colleges, and where it is possible there are chairs of mineralogy and lithology, apart from geology proper, with well-appointed laboratories and collections, as well as special instruction in paleontology, given by experts; while trained assistants in dynamical geology take classes out for field observation.

But, however the work of instruction be performed, the grand outlines of the study should be impressed on the mind of the student, and the teacher should have a philosophic grasp of the subject; and it is on account of the philosophic and general bearings of geology that it should form a conspicuous element in any liberal curriculum.

Geology, then, in its broadest scope should be taught in our schools and colleges, and for at least twelve good reasons.

At the outset we would claim that it holds equal rank with astronomy or biology. The former science tells us of the existence of other worlds than ours, and gives us some conception of the immensity of space. The study of plants and animals carries an impressive lesson as to the unity prevailing amid all the diversity of Nature, besides affording the hope that we may at some time discover the origin of life, since it has already opened the way to an explanation of the origin of the existing forms of life; while the grand outcome of geological study is that it brings vividly before the mind the immensity of time, enabling us to realize that time is only less than eternity. It also teaches us that our earth has had a history, that our own race has had a high antiquity; and thus the contemplation of past geological ages, reckoned by millions of years, the fact that our earth is coeval with the sun in age—all these considerations tend to immeasurably expand our mental horizon, and thus to react in a way to broaden the mind.

Geology is also the complement of biology. As soon as one has mastered the rudiments of botany and zoölogy, and of the distribution of life-forms in space, the range of his thoughts should be extended to take in the orderly succession of life in past ages, and the evolution of modern specialized plants and animals from the earlier, generalized types. No liberally educated person can, then, afford to ignore the study, and it seems to us that it should be taken up for the following, among many other considerations:

1. Our first reason is that geology throws light on the origin of our earth and of the solar system in general; the facts and speculations which culminated in the modern nebular hypothesis give some idea of the steps by which our planet assumed its present form and became adapted for the maintenance of life.

2. After the earth cooled down and assumed its present shape and size; in some way unknown to us, monads and bacteria, together with infusoria, one-celled plants and animals, began to exist, and geology hints that the period when all this became possible may have been the early Laurentian, or at least at the dawn of what, for a better name, we call archæan time.

3. We now feel quite sure that the diversity of life of the Cambrian period must have been in some way the result of great changes in the physical geography of that time, and correlated with the inequalities of the sea-bottom, with regions of shallows and of abysses, with landlocked areas, islands, and incipient continents, rising from submarine plateaus bearing mountain-chains. Geology describes the birth of continents, the rise of mountain-chains, and discusses the results of the action of heat in transforming the physical features of our globe, and thus, in part at least, explains the origin of volcanoes, the causes of earthquakes, and the processes of mountain-carving, through the agency of brooks and rivers.

4. Over immense tracts of mountainous regions, rocks, origi-

nally stratified, and packed with the remains of living beings, have been transformed into slates, schists, and other crystalline rocks, and the inquiry, how this has been done, can only be answered by the geologist.

5. During the process of mountain-building the earth's crust has been uplifted, shattered, or dislocated, and finally permeated by hot springs, and the cracks and rents extending to the surface filled with the precious minerals. Certainly there is good reason why we should know how the ores thus came to be brought up from the bowels of the earth and almost laid at our doors. Theoretical geology gives us the probable explanation.

6. Our North American continent has had a beginning, has passed through a period of infancy, youth, and maturity; the mountain-ranges bounding it are of different ages; its varying climates have become gradually established, and at different epochs it was fitted for the maintenance of quite different assemblages of plants and animals. The intimate relationship between these successive plant and animal worlds and the ground on which they were born, flourished, and died is now tolerably well understood by our geologists.

7. Coal and coal-oils are geological products. Geologists can now give a satisfactory account of just how coal-beds have been formed from vast peat swamps; why great beds of iron ore are interstratified with the coal. We have only had our attention drawn to coal-oils since 1860, but already our geologists feel confident that they are due to the immense profusion of marine animals or vegetables, or both, during the times before and since the great Coal period; and chemical geologists nearly all agree in believing that petroleum is due to the storage in the earth of the chemical products derived from the tissues and oily matters once forming part of the bodies of myriads of living beings.

8. It is interesting to know, and history-classes learn, the mode of origin of the people of Greece, of Rome, of the making of Great Britain, the mode of origin of the French or German peoples, and the successive steps in the history of our own nation. It is equally important to know when the worms, ascidians, early vertebrates, and fishes made their appearance; when it became possible for air-breathing vertebrates to exist, and when the forerunners of mammals and man, the amphibians, were evolved from the ganoids. Paleontology throws light on these points, if intelligently studied and properly taught.

9. Much time is given in our schools to the memorizing of the dates of the birth and death of kings and of dynasties. Why should not the pupil also learn the geological date of the first known appearance of mollusks, star-fishes, worms, insects, fishes, reptiles, birds, and beasts? There are a great many isolated

facts and dry details in the study of fossils; but the leading conclusions, particularly those treating of the elaboration of the lines of forms resulting in the modern horse, the ox, the camel, and our other domestic animals, can be made interesting, and indeed juicy and palatable, to the bright boy or girl of fifteen, or to the college student.

10. The discovery of a single ammonite enabled the geologist to determine the geological age of the gold-bearing rocks of California. How indispensable fossils are as time-marks, characterizing the different formations, and the immediate practical use of such facts to the mining prospector, always interest a geological class.

11. If, as is not improbable, man was evolved from some lemur-like form, and pursued a line of development parallel to, but immensely surpassing, that followed by the lines culminating in the monkeys and apes, it is a matter of deep interest to learn the probable time when vertebrate animals in which the fore legs were used for climbing appeared; when such was the struggle for existence that the ordinary mammalian equipment did not suffice, and the brain was called upon to act more immediately, the limbs and skull being remolded, in a way before unknown, to answer the behests of growing intellectual powers, until man as man appeared. Paleontology again must be invoked, and who knows how soon, when we learn more of the later Tertiaries of Africa and Madagascar, light may flash forth and illuminate this dark problem!

12. One of the triumphs of modern geology is that it has established the fact of the high antiquity of man; that it has brought forth out of caves and gravel-beds the man of Neanderthal, the man of Spy, the inhabitants of the caves and shelters of central France and of southern England; and told us what manner of men they were, what weapons they used, the nature of their dwellings, of their clothing, their art instincts, their *cuisine*, and something of their religious aspirations, as shown in the burial of their dead. It is those antiquarians and geologists who began with the study of zoölogy and of geology who have founded anthropology, the youngest of the sciences. It is thus due to the geologist that the old science of ethnology has been rehabilitated—in fact, rejuvenated.

It is owing to the combined labors of geologists and anthropologists that an entirely different view is now taken of the origin of man. It is almost a matter of scientific truth that primitive man was inferior to the lowest of existing savages; that our present Australian and negro races are physically and intellectually, perhaps, on a higher plane than the race of Neanderthal and of Spy; and that there has been a geological succession of human types, leading up to races of which our existing savages are the descendants. Physically, man of the present time is a most composite being, the result of crossings which began to take place long before the dawn of history. And, finally, it has been left for the geologists and archæologists, of whom Lyell, Lartet, Mortillet, and others, are types, to point out the overlapping of prehistoric upon historic times, and thus to bring to light the lost ages, filling up the abyss in our knowledge formerly existing between the dawn of human history and the close of geological history.

Such is the light which geology has already thrown upon the origin of man, and of the world in which he lives. Who can deny the utility and importance of a study which bears such fruits? How can a person be regarded as liberally educated who has not been brought in contact with these facts? And yet there are still hundreds and thousands of our college graduates who have neither had careful training in the principles, nor have been brought into contact with the grand results of modern geology; whose minds have not felt the inspiration and mental tension resulting from contact with these wonderful discoveries and conclusions. Is there not every reason why geology should be taught, provided the facts and principles be imparted in a way to stimulate, quicken, and expand the mind?

Brown University.

THE LIMITATIONS OF THE HEALING ART.

By Prof. Dr. HERRMANN NOTHNAGEL, of Vienna.*

THE fact is very evident that the practical art of healing has made great advances during the past century, especially during the last half of it. The progress of dermatology, the brilliant career of ophthalmology, the new creation of laryngology, the wonderful development of operative surgery and gynæcology, and, in the line of internal curatives, the introduction of a series of effective remedial substances and physical methods of healing, and, further, the greater importance attached to physiological, dietetical, and hygienic factors of the most diversified sorts—have all taken place during this period, and in part in the very presence of our contemporaries. And when we add to Lister's antiseptic process Pasteur's discovery of the antidote for rabies, and Koch's communication of a cure for consumption, which was received a year ago with such unbounded enthusiasm, the question may well force itself upon us, Where are the limits of the

* From an address before the Association of German Naturalists and Physicians at Halle.

healing art? It is indeed humanly proper to hope for a still wider extension of its scope, and it is a duty to try to obtain it. But it is becoming to the scientific man to look without prepossessions only at the facts, and with calm consideration to take account, not of what has been obtained only, but of what is attainable.

"Being ill is life under changed conditions." What, then, is it to heal? To influence pathological processes in the organism in such a way that they shall be brought to a halt, that the deranged tissues and disturbed functions shall be restored to the normal, and the interrupted interchanges between individual tissues and functions and the whole system shall be brought back to healthful relations; that is what we call healing.

Healing, in the sense that the physician's art can control organic processes in full activity, has not been advanced by the practical progress that has been made through antisepsis. For a tumor or an abscess can no more be made to go backward at this time than formerly. The exsection and opening of them are not synonymous with a real cure. And as with superficial lesions and those arising from external causes, so it is with those in the interior organism, out of whatever causes they may have originated. In an ulceration of the bowels, a cure may be speeded by a series of appropriate measures to the extent that further injuries may be prevented, but the restoration of the injured parts will not be accomplished by them. On the bursting of a blood-vessel and the lesion of the brain-substance, it is necessary to apply suitable preventives to limit the congestion of the brain; but no measure of the surgeon hastens the coagulation of the blood or the adhesion of the divided nerve-substance.

Inflammations constitute another class of clinical affections, either acute or chronic, which, appearing in different organs, are grouped under that single designation. As we know from daily experience, the acute forms of inflammation are often cured, the chronic more rarely. There is, however, no internal medicament of demonstrated direct application for acute inflammations. Such remedies can only act indirectly in special cases—as, for instance, most means in acute catarrhs—as supporting applications.

The therapeutic potentiality of the physician's art is its most ancient possession, grossly overapplied through centuries, then abruptly abandoned in part, and now wavering in uncertainty. Quiet, cold, and local bloodletting are the basis of a treatment which is, under well-defined conditions, very helpful in acute inflammations. But it is sometimes fruitless, sometimes inapplicable. Deep inflammations, skin eruptions, and processes that set in with great activity, are regarded quite apart from specific forms like tuberculosis; and still it is far from being proved that the therapeutic treatment, even when the symptoms have subsided under its application, have had a direct effect on the progress of the inflammation. Although it may appear to be so, it is no way demonstrated. It is the same also with chronic inflammatory processes. The subsidence of single favorably localized forms may perhaps be promoted by such measures as massage, gymnastics, electricity, special baths, etc.; but of them all it can only be said that they promote absorption; but no immediate influence on the organism, no cure of the processes, is worked by them. It may be all the same to the patient whether massage controls the restorative process directly or indirectly, so that it makes him well. In many other instances the application of similar methods in favorable cases may overcome individual symptoms, and remove the products of the disease, without yet having any essential influence upon its progress. The various diseases of the blood, metabolic derangements, and the inexhaustible multitude of disorders of the nervous system, to this time have furnished no more opportunities for a real cure than the soil of Alaska for the successful cultivation of the date palm. Among infectious diseases we admit only that in typhus, scarlet fever, measles, dysentery, cholera, and the long, dangerous host of such contracting diseases, medical art can contribute much to a favorable outcome by counteracting dangerous symptoms, and through general hygienic measures and a judicious direction of nourishment. But in only two, perhaps three, of these diseases can medicine induce a cure by direct influence upon the pathological processes—viz., on malaria, syphilis, and acute rheumatism. Of the last, we only know that the salicylic treatment allays the fever and the joint affection, but is without influence on the dangerous endocarditis, with its following of disordered heart-rhythm. And all other infections, when they have become outbroken and developed illness, can not to this day be cured in the sense in which science uses that word. Whichever way one turns he will everywhere strike limits. In fact, a diseased condition is susceptible of cure only so long as it is attacked while still advancing; as soon as it has reached a definite culmination, no more; there then remain deformations, atrophies, hypertrophies, and other resultants of most various kinds. In most cases these are out of the reach of therapeutic influence and restorative process, except occasionally through a mechanical measure or the knife of the surgeon. An acute pleurisy is curable, but not its residues. The metabolic anomalies which lead to the formation of calculus in the kidneys can be influenced in the beginning, but the stone when it is formed can be removed only by the surgeon. The possibility of therapeutic effect is in many cases determined by the locality of the process, and, further, by the circumstance whether the cause of disease accrued suddenly or gradually, or set in with greater or less intensity. A quantity of arsenic which ordinarily would kill at once, is borne by the habitual arsenic-eater. Of two similarly constituted persons, cholera will take one away at once, while another will escape with a light attack. A disease is also incurable when its causes work on without interruption. Malaria induces an incurably chronic condition if the infected person does not leave the impregnated marsh-land of his residence. A bronchial catarrh continues stationary, and at last draws the lungs into sympathy with it, if the person attacked by it remains constantly exposed to a dusty atmosphere. With like suddenness and energy of the causes of disease, with like continuance of the local processes, the individual's power of resistance, the vigor of his constitution are important factors in determining the outcome. A vigorous thirty-year-old man will overcome an inflammation of the lungs which would be fatal to an old man, to a drinker, or to a man weakened by luxury or a life of dissipation or suffering. Finally, *crimen non est artis, sed ægroti*—the fault is not of the art, but of the patient—is the phrase that may be applied to those cases in which the most correct measures taken under favorable circumstances fail to accomplish their purpose, because the patient himself does not or can not co-operate with them. No treatment can relieve the smoker from his throat-catarrh, so long as he persists in his habit. This aspect of the case is especially pertinent to the nervous disorders which are one of the growing scourges of our age; incapacity and vacillation, the force of outer influences, or the pressure of business too often intervene to interrupt a cure which was otherwise fairly possible.

Gloomy as are the prospects which we have before us here, we still recognize that all diseases which do not fall under one of these mentioned categories are curable, or that their curability is only a question of time. Strange as it may sound in the present state of medicine, we believe that the possibility of in time curing malignant tumors is not yet closed.

Real healing, the restoration to their normal state of functions and tissues that have been changed by disease, is brought about in its essentials only through the life-processes in the organism. Therefore the answer to the question to what degree the healing art is or may be in a condition to influence these processes will be decisive as to whether it shall enlarge the boundaries of its knowledge. And if it results that this can not be, or can be only within a small compass, then will arise the further question whether the object shall be hopelessly given up, or whether still other possibilities are open for medicine to strive after its high aim. It will never be possible to re-form lost cells or to cause separated ones to grow together again; never immediately to affect the processes which play in hallucinations their wild pranks in the ganglion-cells and associative paths.

We can certainly by the application of certain substances cause changes in particular cells which are expressed, albeit in some unknown way, by physiological effects. Thus many alkaloids, alcohol, ether, chloroform, bromine, curare, digitalis, etc., operate directly on particular cell-groups, and bundles of nerves and muscles; pilocarpine, arsenic, and iodine on certain glands; phosphorus on growth processes in the bones. When the cases at present known are analyzed, it is found that bromine restrains the paroxysms of epilepsy for a short time, but does not remove the processes in the central nervous system from which they originate. Alcohol in moderate doses temporarily excites the brain and heart to activity, but does not cure a single pathological condition the presence of which made the administration of alcohol necessary. Morphine alleviates the pains of neuralgia, but does not effect any fundamental change in the disease. Sometimes effects appear like those of iodine in certain diseases corresponding with a real cure brought about by the means itself; but it is still the last experience of medical art that the restoration from the diseased condition, in the true sense of the word, must come to pass through the organism itself. Whether an order of thoughts like that which Robert Koch developed in his studies of tuberculin will lead to this end must be learned by clinical experiment. It may be that the healing art will make its advance in this way. For the present we must learn, the more impressively as medical knowledge becomes more perfect, that the doctor is only the servant of Nature, not its master.

Although the expectation and the possibility of controlling the fundamentals of pathological processes are so limited, the healing art is nevertheless not doomed to vain contemplation and inactive dallying. While art can not master Nature, it can follow it with diligent observation. The truth of this remark covers a genuine progress, and furnishes the key to the secret of the success of really great physicians. To investigate the exact origin of pathological changes, to ascertain by what methods and under what conditions disturbances of the organism are most easily overcome or counterbalanced, deliberately to support and imitate these methods if possible, and before everything to do no harm, is the way by which the healing art can accomplish something important and good. History proves incontestably that practical efficiency at the sick-bed goes in an exactly parallel line with the cultivation of scientific methods. Medicine to-day, without yet being able directly to cure the pathological condition, reaches, simply by following the principles here laid down, incomparably more favorable results than formerly. It has learned, first of all, not to interfere so as to destroy the course of natural compensations; but seeks—by dietetical, hygienic, and climatic influences, here by the removal of excitants, there by methodical stimulation of the matter-changes of the nervous system—to put the organism into a condition to overcome the pathological disturbances. To use such measures, carefully adapted on principles of scientific observation and enlarged knowledge of the course of disease to the most diverse conditions, continually to furnish a closer support to the natural compensations and adaptations—that is one of the ways to which the healing art must turn in order to enlarge its scope.

Since we know that already developed pathological processes can be only imperfectly or not at all affected by art, it should be our more inflexible purpose to guard against their beginning, to recognize the causes of disease, and render them harmless. But this purpose must be comprehended in its widest sense; it should not be confined to the prevention of infectious diseases alone, or to mere measures of sanitary policy, but should also include specific means of cure. Thus, the treatment of malarious disease with quinine is to all appearance etiological. The changes that have already taken place in the blood-cells and the spleen are not reversed by quinine, but the plasmodia of malaria are in some way destroyed, and then the disease may be cured.

The hope is not unjustified that in a nearer or further future we shall learn to nullify by specific means the promoters of disease in many other infections. After nullifying the irritating causes, the processes of Nature may be relied upon to complete the cure. It is possible that this advance will be perfected incidentally, as has happened with quinine and malarious disease, and with salicylic acid and rheumatism. There is also good ground here for the hope that methodical research will be rich in results. The fruitful investigations of numerous contemporary laborers permit much to be expected. And though the conflict of opinions sways hither and thither, and although the knowledge that has been gained relates only to diseases of animals, there is no vital reason for supposing that the same results will not also be reached for man.

The efforts of the present are turned in three directions: to cure bacterial diseases that have already become clinically visible; to make infections harmless while in their incubatory stages; and especially to ward off infection. The last-named object is the farthest-reaching one. It can be attained in two ways: by sanitary protective measures against epidemics, and by conferring immunity on the individual organism, of which vaccination for small-pox is a typical example. Securing artificial immunity by inoculation, and its scientific basis, are now in the full flow of investigation. However favorable results may be reached in it, it seems practically clear that preventive immunity, even when we have gained sufficient experience in it, will be conferred only against those infections to which many men are likely to be exposed—such as small-pox, measles, possibly scarlet fever, whooping-cough, inflammation of the lungs, diphtheria, and enteric fever; in the time of approaching epidemics, as cholera, influenza, and typhus and relapsing fever. On the other hand, it is extremely improbable that preventive measures of immunity will be adopted against rabies, anthrax, and tetanus. The problem of warding off and removing the causes evidently exists in the greatest possible comprehensiveness, and in the most diverse other conditions, but its working is not so strikingly manifested in them as it is against bacterial infections.

While art is limited, in the curing of pathological processes, by the impossibility of changing the course of life at pleasure; while it also reaches limitations in warding off disease, yet its function is not exhausted; there still remains to it the extraordinarily important work of treating symptoms. An inconceivable number of pharmaceutical preparations look directly to this purpose. In numerous cases, also, the application of burning and bath-cures, of electricity, and many other therapeutic helps, is made for the same end. The importance of this part of the art is not underrated. It is often indifferent to the patient whether these or those anatomical and functional changes take place; he will have no perception of them, will not be disturbed by them in his capacity or have his life shortened by them. But symptomatic treatment often makes natural cure possible; it bridges over dangerous episodes in the course of the disease. And no person to whom intelligent management by a physician has preserved a dear one will think little of the treatment of symptoms.

In this the healing art is not only capable of extraordinary progress, but is actually advancing in an encouraging degree. Since Griesinger lamented, thirty years ago, that the doctor was helpless in the heat of fever, we can now, by the cold-water treatment and a number of strong antipyretics, keep a typhus patient almost continuously at the normal temperature. Recent years have furnished numerous soporifics and antiseptics, pilocarpine and cocaine and others, and the present is equally fruitful in the introduction of symptomatic methods. Everywhere active life, fresh labors; and, amid all of it, every human existence which comes to a premature end, every person who is hampered in his career by chronic disease, admonishes us that here are the limits of medical art. Some of these barriers it will never raise; at best, it will be able only to push them further on.—*Translated for The Popular Science Monthly from the Pharmaceutische Rundschau.*

DENDRITES.

By M. STANISLAS MEUNIER.

THERE is a universal tendency to seek and sometimes to see in the forms of objects around us representations of the human figure or of animals and plants. Many interesting examples have been recorded and pictured in La Nature of rocks and mountains presenting resemblances to animated forms. We are quite ready to discern in the clouds all sorts of personages; and at periods when superstition has been active, apparitions have been described, the whole existence of which consisted of misinterpreted simple resemblances. Stones have usually been considered especially worthy of attention in this category; in tubercles of sandstone and nodules of flint it is easy to find features analogous with the most various objects. A block of sandstone is exhibited in the forest of Fontainebleau on which one willing to see it may recognize a petrified knight on his horse, all of the natural size. A nodule of sandstone was once brought to me in the geological laboratory of the museum, on which the owner saw the portrait of our Lord on the cross. Some persons are specially ingenious in finding resemblances in flints; and Boucher de Perthes admitted into his Atlas of Celtic and Antediluvian Antiquities a whole series of figures of imitative forms of that mineral.

There is no limit to this line of curiosities. All sorts of subjects may be found—calves' heads, which are quite common, and eyes, birds, fishes, detached hands, feet, and ears, and human profiles. A large flint was kept for a long time at Meudon, on which everybody recognized the bust of Louis XIV. To such accidents M. J. B. Robinet, in 1778, devoted a part of his ingenious Considerations on the Efforts of Nature in trying to make Man (*Considérations sur les essais de la Nature qui apprend à faire l'homme*). As we turn the leaves of this curious work we see described, in distinct paragraphs, *anthropocardites*, representing the heart of man; *encephalites*, or brains; *cranoïdes*, or skulls; *otites*, or ear-stones; *leucophthalmos*, or white eyes; *chirites*, or hands; stones representing a muscle, and even the olfactory nerve, etc.

The drawing of the distinction between fortuitous resemblances and true fossils was protracted and made difficult by the fact that the two forms are often mingled, sometimes associated in the same specimen or originating in beds having the most essential characteristics in common.

Sometimes, for instance, fossils are reduced to the condition of impressions squeezed between two beds of rock or between two laminæ of a schistose stone. Fishes and insects are found in this condition, and plants in prodigious abundance. Accidental cases of color or structure externally resembling these may be found under similar conditions—more or less complicated figures in which it will be often easy to find such resemblances as clouds or the arabesques of a tapestry give us. Fig. 1 represents an example of this kind, from the *Saxonia Subterranea* of Mylius (Leipsic, 1709); it is the picture of a stone the fracture of which exhibits spots making out the figure of a fowl with her plumage, comb, and the scutels of the tarsi.

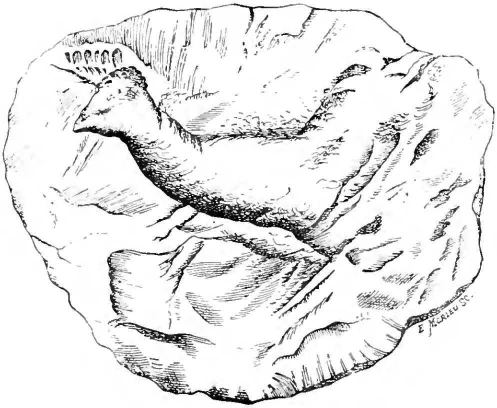


Fig. 1.—Stone, the fracture of which presents the appearance of a feathered fowl. (After Mylius.)

A class of accidents of a different character is especially fruitful of surprises of the kind under consideration. These are the *dendrites*, which are very frequent in joints of rocks of all ages, and of which Fig. 2 gives a very exact idea. At Romainville and Argenteuil, near Paris, we may see in the plaster quarries that all the fissures crossing the beds of marl, whatever their color, white,

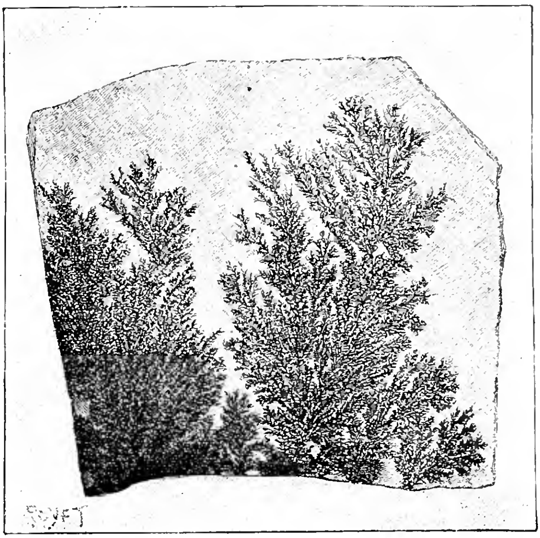


Fig. 2.—Dendrite, composed of small crystals of ferriferous oxide of manganese—the acerdesis of mineralogists; found in the fissures of a lithographic limestone. (Specimen from the Museum of Natural History; half the natural size.)

green, or gray, with which the gypsum is cut up, are darkened with dendrites of various dimensions and sometimes very elegant. These dendrites are likewise found in limestones, chalk, building-stones, lithographic stones, and compact marbles; in sandstones, granite, and various other crystalline rocks. They are not always black; some are the color of rust; some are metallic, and consist of common pyrites between sheets of slate, or copper, or native silver, or gold. Finally, besides superficial dendrites, deep ones are known, which are developed across the mass of the stones. The best-known specimens of this kind are those which make appropriate the special designation of arborized agate (Fig. 3).

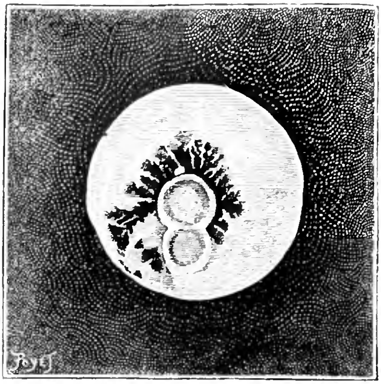


Fig. 3.—Arborized Agate; that is, agate inclosing a dendrite deep in its mass. (Specimen from the Museum of Natural History; half the natural size.)

This name, like that of dendrites, shows that a vegetable origin was at first attributed to these accidents. Sometimes fancy went further; and Fig. 4 represents, from Mylius, whom we have already quoted, the figure of a dendrite in which the author saw a landscape—a plain traversed by a river and bordered by a chain of wooded hills, and pierced with caves. It is easy to discover that dendrites have none of the characteristics of the vegetable ramifications with which we are at first inclined to compare them, and, when we study them under a sufficient magnifying power, the crystalline structure of most of them appears distinctly. This is especially the case with the black dendrites, which are most abundant, and is shown in the originals of Figs. 2 and 4, which I have particularly studied, and have been able to produce artificially.

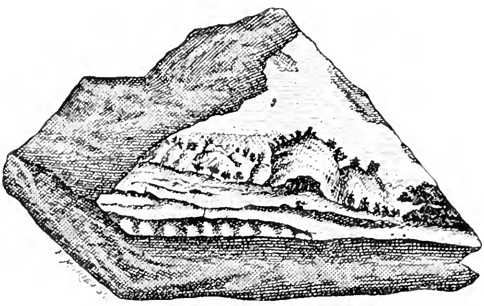


Fig. 4.—Schist, exhibiting dendrites, in which the representation of a landscape may be imagined.

It is evident that these dendrites, which consist of a hydrated oxide of manganese—the acerdesis of mineralogists—are the result of a precipitating action exercised by calcareous rocks on water containing traces of metallic salts. Hence we might expect to obtain an imitation of them by placing pieces of marble or lithographic stone in a dilute solution of chloride or sulphate of manganese. The hope of success is all the more legitimate because carbonate of lime has already permitted the imitation in this way of several natural minerals, particularly of limonite, an iron mineral, and bauxite, or the mineral of aluminum. But the experiment has not been successful, and, instead of the desired black deposit, we get only chocolate-brown flakes having no resemblance to the substance of the dendrites.

Seeking for the causes of this want of success, I have found, by analysis, that the dendrites said to be of manganese contain oxide of iron, in minute proportions it is true, but in proportions that seem to be sufficient. And the addition of traces of ferric salts to the solution of manganese salt has really determined the deposit on the limestone surface of a perfectly black compound, presenting in many cases the exact form of the dendrites of Nature. I have in the museum specimens that leave no doubt on the subject, the inferiority of which to the models which I sought to copy is most probably due to the inferior slowness of the process of producing them.—*Translated for The Popular Science Monthly from La Nature.*

ENERGY AS A FACTOR IN AGRICULTURE.*

By Dr. MANLY MILES.

THE rapid development of science and its numerous applications in the industrial arts are leading to a general recognition of its importance as a factor in the material and intellectual progress of the age. The aid of science is now invoked in every department of human activity, and, judging from what has already been accomplished, we can not perceive any indications of a limit to its useful applications in the industries.

While the general outlook encourages optimistic views in regard to the present and prospective advantages that may be realized from the applications of science, we should not overlook the shadows involved in its progress, which seriously interfere with its own advancement, and at the same time increase the difficulties attending original investigations relating to many industrial problems.

The scope and extended range of modern science, that necessitate a subdivision of its lines of research into numerous branches,

* An abstract of this paper was read at the Washington meeting of the American Association of Science, and also before the Society for the Promotion of Agricultural Science.

each of which requires a lifetime of diligent study for its mastery, are serious obstacles in the investigation of a certain class of problems that can only be solved by contributions from the entire circle of the sciences.

Prof. Huxley has sounded a note of warning which should be heeded, especially by those who are engaged in conducting experiments for the advancement of agricultural science. In his retiring address as President of the Royal Society he says: "Of late years it has struck me with constantly increasing force that those who have toiled for the advancement of science are in a fair way of being overwhelmed by the realization of their own wishes. We are in the case of Tarpeia, who opened the gates of the Roman citadel to the Sabines, and was crushed under the weight of the reward bestowed upon her. It has become impossible for any man to keep pace with the progress of the whole of any important branch of science. If he were to attempt to do so his mental faculties would be crushed by the multitude of journals and voluminous monographs which a too fertile press casts upon him. This was not the case in my young days. A diligent reader might then keep fairly informed of all that was going on without demoralizing his faculties by the accumulation of unassimilated information. It looks as if the scientific, like other revolutions, meant to devour its own children; as if the growth of science tended to overwhelm its votaries; as if the man of science of the future were condemned to diminish into a narrower and narrower specialist as time goes on.

"I am happy to say that I do not think any such catastrophe a necessary consequence of the growth of science; but I do think it is a tendency to be feared, and an evil to be most carefully provided against. The man who works away at one corner of Nature, shutting his eyes to all the rest, diminishes his chances of seeing what is to be seen in that corner; for, as I need hardly remind my present hearers, that which the investigator perceives depends much more on that which lies behind his sense-organs than on the object in front of them.

"It appears to me that the only defense against this tendency to the degeneration of scientific workers lies in the organization and extension of scientific education in such a manner as to secure breadth of culture without superficiality; and, on the other hand, depth and precision of knowledge without narrowness."

From the exceeding complexity of many of the problems in agricultural science, and the number of factors that require consideration in attempts to solve them, there is especial need of guarding against the dangers attending the exclusive prosecution of special lines of research, which are so forcibly stated by Prof. Huxley with reference to the general advancement of science.

In almost every problem in agriculture the complex phenomena of life are directly concerned, under various forms and activities, which can not be expressed or formulated in chemical terms, from the self-evident truth that the part can not contain the whole. The significance and interdependent relations of the biological factors in agriculture are unavoidably obscured by the exclusive consideration of specific details which, with the advance of knowledge, may prove to be but incidents in the manifestations of general laws.

The solution of these Protean problems can only be secured by abstract researches to determine the relations of the several factors to each other, and to the general laws of which they are the expression. The principles of science that are admitted to be of general application are the only safe guides in developing an improved and rational system of agriculture, while the purely empirical lines of research that aim to discover specific rules of practice, and thus gain immediate practical results, retard the march of progress by the delusive importance assigned to non-essential details.

The truth of these statements may be illustrated by the remarkable progress of the physical sciences in the past quarter of a century, and the rapid development of the industrial arts through the recognition and applications of the principle of the conservation of energy, which Faraday looked upon as "the highest law in physical science which our faculties permit us to perceive," and Huxley refers to, in connection with evolution, as "the greatest of all of the generalizations of science."

The principle of the conservation of energy, which is now generally admitted to be a prime factor in Nature's operations, has not received adequate attention in agricultural science. It is true that in general terms it has been incidentally referred to as a factor in biology, more particularly with reference to mechanical work, but the dominance of purely chemical considerations has prevented its real significance in all organic processes from being fully recognized.

More than twenty-five years ago, Dr. William B. Carpenter pointed out to physiologists the "distinction between the *dynamical* and the *material* conditions; the former supplying the power which does the work, while the latter affords the *instrumental means* through which that power operates."

The material conditions have, however, continued to receive a predominant, and almost exclusive, share of attention, and the manifestations of energy in the processes of vegetable and animal nutrition have practically been ignored.

In the applications of science to agriculture, and especially in planning and conducting experiments, the transformations of matter have been looked upon as the sole factors requiring attention, and a simplicity in organic processes has been assumed that is not warranted by our present knowledge of the conditions that have a decided influence on the nutrition and well-being of plants and animals.

An approximate quantitative estimate of the expenditure of energy in certain processes of Nature involved in growing a field crop will serve to illustrate its importance in biological science and farm economy, and a preliminary review of some of the salient points in the economy of plants will simplify the problem we have to deal with.

A growing crop, in common with other living organisms, requires certain conditions of environment for the healthy and vigorous exercise of its vital activities, among which may be enumerated as essential, a suitable temperature, a certain supply of moisture, and a sufficient food-supply; and to these must be added soil conditions that promote an extended root development and distribution.

Plants differ as to the temperature required for active growth, but there is for each a minimum, below which growth ceases; a maximum, above which life is destroyed; and between these an optimum temperature which is most favorable for the activity of the processes of nutrition. The temperature of the atmosphere, which is an incident of seasons, need not be noticed here, but it may be remarked that it is of less practical importance than soil temperatures, which depend on conditions that, to some extent, may be controlled.

Plants obtain their supply of water from the diffused moisture of the soil, which is retained by capillary attraction. In fertile soils this capillary water is kept in constant circulation by the drafts made upon it by growing plants, and by the evaporation which takes place from the surface soil, and an equilibrium is thus maintained in the distribution of soluble soil constituents, and in the processes of soil metabolism.*

To say nothing of other important considerations, it is evident that soil conditions favorable for the extended distribution of the roots of plants are necessary to enable them to obtain their needed supplies of water from the comparatively limited amount present in the soil. As the water evaporated from the surface soil is replaced from below by capillary attraction, its influence on soil metabolism and the transportation of soluble soil constituents toward the surface strata should receive attention as a factor in the

* The series of chemical, physical, and biological changes taking place in the soil, or in the processes of vegetable and animal nutrition, are conveniently expressed by the general term *metabolism*, and they are frequently designated as *metabolic processes*.

economy of plant growth that is closely related to that presented by the water absorbed by the roots of plants and exhaled by their leaves.

Energy has been defined as "the power of doing work, or overcoming resistance," and its varied transformations into heat, motion, electricity, etc., without gain or loss, are expressed by the general term conservation of energy. In the nutrition and growth of plants an expenditure of energy is evidently required in the work involved in a number of distinct, but correlated, processes, the most important of which are—constructive metabolism, or the building of organic substance; the exhalation of water by the leaves, which is constantly taking place in their processes of nutrition; the evaporation of water from the surface soil; and the warming of the soil to provide optimum conditions of temperature.

The energy expended in constructive metabolism, or tissue-building, is stored up as potential energy, and reappears as heat when the plant is decomposed by any process, as, for example, when it is burned. The mechanical force exhibited by growing plants is a phase of the constructive process that has often been noticed. President Clark's squash raised a weight of 4,120 pounds in its processes of growth. Sprouts from the roots of a tree pushing their way through an asphalt pavement have been observed by myself, and many similar exhibitions of the force exerted by growing plants are often seen.

These obvious manifestations of energy in constructive metabolism are, however, so familiar that they require but a passing notice, and we will proceed to consider the much larger expenditures of energy involved in vaporizing the water exhaled by the leaves of plants and evaporated from the surface soil, as these unobtrusive and incidental processes, as they might be termed, are quite as significant factors in plant growth as the direct work of building organic substance, to which the attention of physiologists is more particularly directed. In field experiments the results obtained with manures must largely depend on the expenditure of energy, under the prescribed conditions, in the work of exhalation by the plants and the evaporation of water from the surface soil. The supply of plant food in the manure may, in fact, be a matter of secondary importance to the growing crop.

Experiments at Rothamsted, England, and on the continent by Hellriegel, on the exhalation of water by a variety of farm crops, including wheat, oats, peas, beans, and clover, show that about three hundred pounds of water are exhaled by the leaves for each pound of dry organic substance formed by the plants. It was estimated by Lawes and Gilbert that the average annual exhalation from the wheat grown on some of the experimental plots at Rothamsted was at the rate of 1,680,000 pounds of water per acre, or the equivalent of 7·4 inches of rainfall; and on the same basis the exhalation from a crop of Indian corn, of 60 bushels per acre, would be equivalent to about 8·5 inches of rainfall.

So far as the expenditure of energy is concerned, it matters not whether water is changed to vapor in the process of exhalation by the crop or in evaporation from the soil, and the same standard of measurement will, therefore, be applicable in both cases.

Energy is measured in heat-units, and work is expressed in foot-pounds or in kilogramme-metres.* For convenience of illustration we will make use of another standard adopted by engineers, which, although not as definite, is sufficiently accurate for our purpose.

From experimental data it has been found that, under favorable conditions, one pound of coal will evaporate from 6·60 to 8·66 pounds of water from an initial temperature of 32° Fahr., according to the quality of the coal used. If we assume that one pound of coal will evaporate 8·5 pounds of water under the conditions presented in crop-growing, our standard will be considerably above what is realized in ordinary steam-engines.

The energy required to vaporize the water exhaled by one acre of corn in its processes of growth, with a yield as above estimated, would, therefore, be represented by the heat produced in burning 226,500 pounds of coal, or over 113 tons. This may be expressed in another form, which will, perhaps, be more readily understood. We are told that "a good condensing engine of large size, supplied with good boilers, consumes two pounds of coal per horse-power per hour." The work involved in the process of exhalation from one acre of corn would, therefore, be equivalent to the work of more than twenty-five horses day and night, without cessation, for six months.

The same standards of measurement applied to the energy expended in evaporating water from the soil will give quite as striking results. With a sufficient rainfall to supply the requirements of a crop, the amount of water evaporated from the soil will vary, within certain comparatively narrow limits, with the amount and distribution of the rainfall, the capacity of the soil for heat, and the atmospheric conditions that influence evaporation, as temperature, humidity, and the character of the prevailing winds.

From the best evidence I can obtain, which need not here be

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* The English heat-unit is the amount of heat required to raise one pound of water 1° Fahr. in temperature, and the French heat-unit, or calorie, is the amount of heat required to raise one kilogramme of water 1° C. in temperature.

A foot-pound = one pound raised one foot.

A kilogramme-metre = one kilogramme (2·2 pounds) raised one metre (3·28 feet).

discussed in detail, it appears safe to estimate the soil evaporation in the Middle States at approximately twice the amount exhaled by a growing crop of fair luxuriance. Of an annual rainfall of thirty-two inches, or over, fairly distributed, we may then assume, with apparent good reason, that about sixteen inches will be disposed of by evaporation from a fertile, well-drained soil, and about eight inches by exhalation from a growing crop, or an aggregate of about twenty-four inches will be disposed of in the form of vapor from soil and crop, involving an expenditure of energy represented by the heat produced by burning 320 tons of coal per acre, or the equivalent of the work of seventy-three horses, day and night, without intermission, for six months. If to this is added the energy expended in constructive metabolism and in warming the soil, which we will not now estimate in specific terms, the sum would represent the normal demands for energy in growing a crop of one acre.

This enormous expenditure of energy appears to be quite as essential to the well-being of the crop as the supply of food constituents, to which attention has been too exclusively directed, and any conditions that tend to materially increase or diminish it must be looked upon as injurious.

From this standpoint the principle of the conservation of energy furnishes most satisfactory data for discussing the philosophy of farm drainage. On undrained, retentive soils, the rain that falls in excess of the normal requirements of the crop and soil metabolism must be removed by evaporation, and this calls for a very considerable expenditure of energy that on drained land might be made available in useful work, to say nothing of the influence of removing surplus water by evaporation on the physical and biological characteristics of the soil.

For each inch of surplus rainfall removed from the soil by evaporation, the energy expended would be represented by 26,600 pounds of coal per acre. With an annual rainfall of forty inches, which is not unusual in the Middle States, and is considerably exceeded in some localities, there would be sixteen inches of water in excess of the normal demands of an ordinary farm crop, and to remove this by evaporation would require the equivalent of about 213 tons of coal per acre, representing the continuous work of forty-eight horses, day and night, for six months. The removal of this surplus water by drainage would obviate the necessity for this enormous expenditure of energy, besides other incidental advantages which we need not notice here.

In the economy of animals the manifestations of the law of the conservation of energy are quite as striking and significant. The potential energy of their food is the sole source of the energy expended in work, and in their processes of nutrition and growth.

Animals have been looked upon as machines for converting the vegetable products of the farm into animal products of greater value, and this in the light of the law of the conservation of energy may be interpreted as the conversion of the potential energy of field crops into the useful work of an animal machine. Considered as machines for the manufacture of definite products, the efficiency of animals must depend upon the amount of work performed for a given supply of energy in their food.

An ordinary steam-engine formerly converted less than one tenth of the potential energy of the fuel consumed into useful work, and the attention of engineers has been directed to improvements in construction to secure greater economy and efficiency in the work performed, by a more complete utilization of the potential energy supplied in the form of coal or other fuel. The remarkable industrial development of the past few years, resulting in a material reduction of the cost of production and transportation, is largely owing to improvements in the steam-engine which have been brought about by a more intelligent application of the principle of the conservation of energy.

There are good reasons for the belief that the animal machine works with greater economy than the steam-engine, even in its improved form, but, according to the most favorable estimates, only a small proportion of the potential energy of foods is utilized in useful work, and there is a broad margin for improvement, even in what we call our improved breeds, to secure a more efficient expenditure of energy.

The problem of paramount interest in animal husbandry is essentially the same the mechanical engineer has been dealing with in his efforts to improve the steam-engine. It is simply to obtain the largest net returns in useful work from the potential energy of the food consumed. It is evident that improvements in the animal machine itself must be the leading object to receive attention, and the breeders of pure-bred stock must recognize this principle in their efforts for improvement. The form and proportions in which the chemical constituents of food are provided are of far less importance than the inherited capacity and capabilities of the animal machine to utilize and economize energy in the work involved in the manufacture of animal products.

When speaking of foods we should bear in mind the fact that there is but a limited demand in the animal economy for the so-called nutritive constituents, aside from their agency in the transformations of energy involved in the metabolism of the system. But a small proportion of the chemical constituents of foods are stored up in the body, even during the period of growth, when the demands for new materials in constructive metabolism are most active, while an abundant supply of energy in an available form must be provided as an essential condition of the manifestations of life. It must not, on the other hand, be assumed that the potential energy of foods may be considered as a reliable index of their physiological value. Biological processes are exceedingly complex, and, in calling attention to energy as a dominant factor in vital activities, we do not lose sight of other important considerations which can not here be noticed.

Protean transformations of energy are constantly carried on in all the metabolic tissues. The energy expended in building organic substance in animals, as in plants, is stored up in the form of potential energy as an essential condition of its constitution, and it is again liberated in the form of heat in the correlative processes of destructive metabolism which are taking place without cessation in the work performed in every operation of the system.

Dr. Foster tells us that what is really meant by the phrase, "*living substance*, is not a thing, or body, of a particular chemical composition, but matter undergoing a series of changes." These metabolic changes are brought about, in the main, at the expense of energy, and they represent in fact successive transformations of energy from the active to the potential form, and a final reconversion to heat, which leaves the body in various ways.

The animal machine is in effect a heat-engine that is constantly being worn out by the work performed, and as constantly repaired by its own processes of nutrition, and the heat leaving the body (animal heat) represents the energy that has been used in internal work, and finally liberated through the agency of destructive metabolism.

We must not, however, carry the analogy of the heat-engine so far as to assume that the food consumed by animals is disposed of by a process of combustion, like the fuel burned under a steam-boiler. There is no evidence that anything like a combustive oxidation of the food constituents, or of the tissues, takes place in the animal economy. The building of organic substance and storing of potential energy (constructive metabolism) is accompanied by parallel processes of disintegration (destructive metabolism), in which the stored potential energy is changed to heat; and these alternate, or possibly simultaneous, transformations of energy which take place in living tissues must be regarded as manifestations of vital activities that differ widely in their characteristic features from the processes of combustive oxidation that take place in non-living matter.

From what is now known in regard to animal physics it will be safe to assume that from four fifths to five sixths of the potential energy of the food consumed and digested by working animals is expended in vaporizing the water thrown off by the skin and lungs, and in the internal work performed by the metabolic tissues in their constructive processes of nutrition, and the energy used in this internal work finally leaves the body as animal heat, a very large proportion of which is the result of muscular and glandular metabolism.

The work performed in twenty-four hours by the heart alone of a man weighing 150 pounds is estimated at 75,000 kilogramme-metres, an expenditure of energy sufficient to raise his own weight to a height of 3,600 feet, and the work performed by other internal organs, and in vaporizing the water thrown off by the skin and lungs, is quite as significant.

The energy expended in some of the unobtrusive operations of Nature that are likely to escape attention may exceed in amount the more obvious expenditures in mechanical work. We readily recognize the demands for energy by an animal moving a heavy load when working eight or ten hours a day, while we fail to notice that from two to three times as much energy is expended by the same animal in the course of twenty-four hours in vaporizing the water thrown off by the lungs and skin. As this energy is all derived from the food consumed, it must be taken into the account as a significant factor in discussing the physiology of nutrition.

Another important fact should not be overlooked. In the reconstructive processes that are carried on without intermission in the living tissues of the animal machine, a supply of energy, as we have seen, must be constantly provided to replace that which is thrown off from the system in the form of heat, or expended in vaporizing water and in external work; but new materials are not required to replace all the disintegrated constituents of the tissues, as there is a rearrangement, to a certain extent, in the processes of repair of the elements of which they are composed. This is especially the case with muscle, which constitutes so large a proportion of the proteid substance of the body. The work performed by muscle is not at the expense of its nitrogenous substance, and its energy is, to a great extent, if not exclusively, derived from the carbohydrate elements of the food. The demands of the proteid substance of muscle for nitrogen are, therefore, limited, and the available supplies of energy in the various elements of the food determine the efficient activity of the animal machinery.

Energy as a factor in animal physics seems to be entirely overlooked in the application of the popular theory of nutritive ratios. There is a wide difference in the potential energy of feeding rations that have been formulated for the same specific purpose, with practically the same nutritive ratio. On the same page of a popular agricultural paper I find two rations for milk-production, the one having a ratio of 1 to 5, and the other of 1 to 5·1, but there is a difference in potential energy in the two rations equivalent to over 2,411,000 kilogramme-metres of work, or one and a quarter horse-power in the day's rations.

In two other rations for milk-production with nutritive ratios of 1 to 5 and 1 to 5·1, the difference in potential energy would be represented by 3,112,000 kilogramme-metres, or 1·6 horse-power for the day's feed.

There are likewise rations with exactly the same nutritive ratio (1 to 5), prescribed for Jersey cows giving milk, in which the difference in potential energy is equivalent to 1,123,600 kilogramme-metres, or more than one half of a horse-power for the day's feed. There are also rations for horses, with nutritive ratios 1 to 6, and 1 to 6·4, which have a difference in energy of 2,834,600 kilogramme-metres, or the equivalent of over one and a quarter horse-power for the day.

It is unnecessary to cite further instances of the obvious fallacies in rations that have been formulated in accordance with a theory which ignores the significance of energy in animal nutrition. The facts already presented must be sufficient to show that the law of the conservation of energy should be recognized as an important factor in the nutrition and growth of both plants and animals, and that it should receive due attention in planning and conducting experiments for the promotion of agricultural science, and in interpreting their results. In the development of a rational system of farm economy the applications of this general law must have a dominant influence in determining the most profitable and consistent methods of practice.

BAD AIR AND BAD HEALTH.

By HAROLD WAGER and AUBERON HERBERT.

[*Concluded.*]

EXERCISE, as well as pure air, helps us in our constant struggle against the poisons that we manufacture within ourselves. It does this by driving the blood charged with oxygen, by means of the pressure of the muscles called into play, more thoroughly through the tissue (Foster, page 219); and thus it would quicken the breaking down of dead tissue into its safe and final waste products (water, carbonic acid, and urea), and shorten the period during which the dead tissue was passing through various dangerous forms which it temporarily assumes. From this fact we may infer that the man of sedentary life, above all others, requires pure air.

In truth, pure air and exercise are equal forces acting in the same direction. They both get rid of waste, and with it of the poisons in the system which are depressing various organs. We need not, therefore, be surprised when we are told by Sir D. Galton that after barracks were better ventilated the rations of the men had to be increased; or by "the pathetic story" of certain seamstresses whose work-room was ventilated, and who then begged that the old state of things might be restored, as their appetites had increased beyond their earnings. Sir D. Galton gives another experience, illustrating the depressive effect of these poisons upon the functions of life. A New York medical man rather cruelly shut up some flies without food, some in foul air, others in pure air; the pure air being constantly changed. To his surprise, the flies in the pure air died first, these dying from simple starvation; while the flies in the foul air died from poison, and with the tissue of their bodies unexhausted, indicating how the functions of life were carried on to the last where oxygen was available, but had been slowed and depressed by the presence of the poison, so that life was actually maintained longer in the foul than in the pure air. To take one more example. Parkes tells us (page 159) that it was found in the case of miners that they required six thousand cubits of air introduced per man per hour (this included the air necessary for horses and lights) to be able to work at their best. When this quantity was reduced to one third or one half, there was a great reduction in their working energy. In other words, the poison within their system being imperfectly oxidized, impaired their faculties.*

We could wish that it were possible to write the whole of the noble story of oxygen from a physiological point of view. It is a double service that it performs for us. It not only, as we have seen, neutralizes the deadly poisons resulting from waste, but it provides the heat and energy, by the oxidizing or burning up of this waste. All through animal life the consumption of oxygen, serving this double purpose, is the measure of activity. Just as reptiles and cold-blooded creatures consume small amounts of oxygen and develop little activity, so birds and insects consume im-

* We may also take the case of races living in hot and cold climates. In hot climates we breathe a smaller quantity of oxygen (owing to the expansion of gases) than in cold climates. Thus, taking two climates, one of 32° F. and the other of 80° F., we should inhale about 2,164 grains of oxygen per hour in the one climate (the cold), and only 1,971 in the other climate (the warm), or a difference of about nine per cent (Galton, Our Homes, p. 498). This would in part account for the difference of energy that exists in the races of hot and cold climates; just as our own energy varies considerably on hot days and keen frosty days, though we think some allowance ought to be made for the more open-air life that would be led in the warm climate. The bearing of these facts upon crowded rooms should be perceived. As the room gets hotter, not only are we breathing more poison, but less oxygen, which is the only remedy for the poison. We are therefore doubling the causes of evil.

mense quantities of oxygen and develop immense activity. Each animal has, as Prof. Foster believes (page 812), its own peculiar quantity, its coefficient, so to speak, of oxygen, which it consumes—an amount which, judging from the few instances he gives, seems to vary with intelligence; thus the dog consumes more than the rabbit per pound of its weight, and a man more than a dog. In the same way, a waking man consumes more oxygen than a sleeping man, a man at work than a sedentary man, a young man than an old man, a young child more than the young man. The restless activity of children marks both their great consumption of oxygen and their pressing need for it by being allowed to breathe abundance of pure air. Rapid and extensive waste is going on in every child's body. Tissue of every kind, including bone, is being constantly broken down in order that it may be built up anew on a larger scale, and it is therefore the greatest cruelty in their case not to provide them in fullest measure with the purest air. Unhappily, very little thought is given to this matter; and with quite young children—whose need is the greatest of all—our nurseries are only too often mere slaughter-houses. Mothers of all classes should try to see the meaning of the fact * that out of four deaths of infants one takes place from lung collapse, a state that often follows bronchial inflammation (see R. D. Powell, Lungs; Quain, page 861), and probably often indicates the source of the mischief. Dr. Douglas Powell significantly says, "All causes that interfere with respiratory efficiency favor the occurrence of the condition named."

It is now right for us to look at the subject of these waste-poisons in special reference to the skin. Without referring here to the different calculations made on this subject, it is enough to say that much less carbonic acid escapes from the skin than from the lungs; more water (if we are to follow Prof. Foster—who differs from other authorities, who again differ among themselves—we may say roughly, 1·5 pound from lungs, and 2·5 pounds from the skin per day), and a larger amount of solid matter The solid matter is put at one or two per cent of the whole 2·5 pounds and two thirds of this one or two per cent is organic matter containing the poisons in question.† We can see the importance of the skin, as an organ of excretion, in various ways. In the first place, the provision of an enormous number of sweat-glands un-

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* So it has been stated. It is also interesting to quote the statement from the Registrar-General's Report for 1889, that there were in that year 71,056 deaths of male infants (not over twelve months) in England, and out of this number, 13,805 (roughly speaking, about one in five) died of diseases connected with the respiratory system. It is right to add that lung collapse may follow many different kinds of illness.

† Thus we should have from 118·3 to 236·6 grains of organic matter excreted by the skin in twenty-four hours.

der the skin, supposed by Krause (Baker's Kirk, page 427) to be between two and three millions in number—in the parts where they are least abundant they are over four hundred to the square inch—offers evidence of a physiological character on the point, even if, as is stated, some small part of skin perspiration takes place independently of these glands. Then we have the evidence of the disagreeable odor from the skin and clothes where cleanliness is not observed; again, we have the curious facts of death having both actually and nearly occurred in cases where the body has been covered (the mouth having been left free) with gold-leaf or plaster of Paris. Various explanations have been given, but Prof. Foster seems to think (page 697) that the retention of poisonous matters—"constituents of sweat, or the products of some abnormal metabolism" (change)—which would have been discharged through the sweat-glands, is largely concerned in the matter. We venture to believe—quite independently of certain experiments—that this conclusion can not be avoided.

We have also a most remarkable case recorded by Sir D. Galton. Some men in the horse artillery had left their bedding rolled up for two months, without its being opened to the air. When first used again, man after man who had slept on this bedding came into hospital with "a suspicious fever." It would be difficult to find a case that more vividly illustrates both the poisonous character of the emanations of the body and the necessity of free ventilation in order to render them harmless. Again, when serious consequences result from a chill—owing to the constriction of the blood-vessels of the skin and interference with the sweat-glands—such as a dangerous affection of the kidneys (Richardson, page 283), or a congestion of the spleen (Richardson, page 307), or the inflammation of bone and periosteum (Richardson, page 323), it seems probable that the cause of mischief in all these cases is either the retention of normal poisons that ought to have escaped through the skin, or the formation of abnormal poisons during the inaction of the skin. [We think it is Dr. Richardson who makes this suggestion.] Again, the fetid exhalations from lungs and skin in starvation seem to show that the breaking down of tissue, which is very rapid in these cases, is resulting in a larger discharge than usual, through skin and lungs, of putrescent matter.

From what has been already said, we ought not to feel surprised that those who live in foul air are not only lowering their health, but are carefully preparing themselves both for lung and bronchial affections, and for such diseases as scarlet fever, typhoid, small-pox, dipththeria, dysentery, cholera, etc. As regards cholera, we extract the following interesting account given by Dr. Carpenter. He states (page 360) that in the fatal autumn of 1849 there was at Taunton an exceedingly badly ventilated workhouse. In the school-rooms there were only sixty-eight cubic feet or less per head. The fatality of the cholera attack—thus carefully prepared for—was awful. Within forty-eight hours after the first attack, nineteen deaths and forty-two seizures had taken place. In the course of a week sixty, or twenty-two per cent of the whole number, died, almost all the others suffering badly. Fewer boys died as compared with girls, because, as it was stated, having even less air than the girls, they used to break the windows. In the jail of the same town, where each prisoner had over 800, and in some cases over 900 cubic feet, and where a system of ventilation kept renewing the air, there was not "the slightest indication of the epidemic influence." In August, 1849, the cholera raged severely in London, the mortality having increased from nearly 1 per 1,000 in June and July to 4½ in August and September. It happened that at this moment a large number of male prisoners were transferred from Millbank Prison—which was in one of the bad districts—to another part of the country, the numbers being thus reduced from over 1,000 to close upon 400; while at the same time the female prisoners were slightly increased in number in Millbank Prison, from 120 to 131. The consequences were remarkable. The mortality of the female prisoners went up from a little over eight to a little over fifty-four per cent (which was considerably above the rate of increase in the outside districts), while the mortality of the men fell from slightly over 23 per 1,000 to nearly 10 (the June and July rate of mortality). Carpenter gives other interesting examples, and also remarks upon the fact that the special centers of cholera existed before the invasion of that disease as fever nests; and that cholera followed the footsteps of other diseases, not only in the same district, but in the same streets and houses, and even rooms.*

As with cholera, so with other causes of death. At Secunderabad, in India, in old days, the barrack accommodation for the line was unusally deficient, and the average annual mortality of the men was nearly double the average of the presidency. At the same station, both the officers, who were well quartered, and the detachment of artillery, who had roomier barracks "at no great distance," did not share in the heightened mortality (Carpenter, page 363). Barrackpore furnished an even worse exam-

* Of course it would be unfair to put all these cases simply and exclusively down to the effects of vitiated air, as we might, perhaps, in the case of the prison quoted above; since overcrowding in towns occurs among the poorest part of the people, living on the worst food, badly clothed, and therefore for these reasons exposed to attacks of disease; but with all such deductions the evidence is of a striking character. Dr. Richardson writes to the same effect. Speaking of relapsing fever, he says, "The disease (1847) followed where the habitation was most crowded" (Our Homes, p. 7); and, again, "Certain it is that homes which are charged with impure atmosphere are the places in which septic diseases are most likely to be intensified and most likely to spread" (Our Homes, p. 21).

ple as regards troops; but the worst of all was to be found in the Indian jails, where, in some instances, 70 cubic feet only of air was the average allowed; in no cases did it exceed 300 cubic feet. The mortality was, as might be expected, one in four. It was a humble imitation of the Black Hole of Calcutta. So at the end of the last century, in the Dublin Lying-in Hospital, the mortality from trismus of the children was one in every six born; by better conditions of ventilation, it was reduced to one in nineteen and a half (Carpenter, page 985); and this number of deaths was again reduced. So in the London workhouses of the last century, twenty-three out of twenty-four children died in their first year. By reforms, especially by improved ventilation, the number of deaths was reduced from between 2,000 and 3,000 to between 400 and 500 (Carpenter, page 365). So with our soldiers. When barracks improved, especially in the matter of ventilation, deaths from zymotic diseases fell from 4·1 per 1,000 to 0·96 per 1,000 (Galton). So in the case of our sailors on board the Rattlesnake, a case which came under the notice of Prof. Huxley. The crew (Carpenter, page 256) had acquired by confinement (this seems to have been the special cause, though not the only cause) a predisposition to disease. No malady appeared, however, until one of them slightly wounded his hand: then typhoid resulted, and ran through the whole ship's company. They had carefully prepared themselves for disease with the poisons of impure air.

We suspect that no class of human beings suffers so much from the poison of foul air as infants. Older children and grown-up persons are seldom so much shut up, and the diseases by which so many infants die, infantile diarrhœa, convulsions, and infantile pneumonia,* strongly suggest the irritation likely to be produced by breathing these waste-poisons; though improper food must also bear a large share of the blame. Of all the evil consequences, however, of foul air none can be traced more surely than phthisis or pulmonary consumption. Wherever men are crowded together without care and proper means to supply them with fresh air, there pulmonary disease shows itself. Parkes, Dr. A. Ransome, Sir D. Galton, and others have collected many interesting examples bearing on this matter.† Sir D. Galton tells us (page 502) that after our barracks were improved—ventilation being one of the leading improvements—chest and tubercular disease, which had been fatal to 10·1 per 1,000 soldiers, was only

* These make up a very large proportion. See lectures by Sutton. Health Lectures, 1879–'80, p. 130.

† "Experiments have recently been made in Berlin, in a room closely shut up after the death of a consumptive patient. Six weeks after the death living microbes of phthisis were found on the mirror, walls, and picture-frames, and these introduced into the body of a guinea-pig produced the disease."—(L. P.)

fatal to 4·2, and in the same way that, with proper ventilation (and other improvements) of the stables of the horses, coughs and catarrhs disappeared. He also quotes Dr. Leeds, of New York, to show that the supposed cure of sending a consumptive patient to a cow-stable was in reality the cure of sending him into somewhat purer air than that of his own room (page 502). Dr. Richardson quotes a case where no less than nine members of a family following the occupation of Cheap Jack were in succession the victims of consumption from sleeping in a traveling van, their life in the open air during the day being insufficient to counteract the poison breathed in the night (Our Homes, page 11). Parkes also tells us (page 152) that in the royal navy and in the mercantile navy bad ventilation and phthisis, occasionally amounting to a veritable epidemic, have accompanied each other; and he quotes many authorities insisting upon the close relation between foul air and pulmonary consumption. On the same point—the slaughter produced by unventilated barracks—Dr. Richardson tells us the mortality in the army before Sebastopol was during twenty-two weeks ending May 31, 1856, at the rate of 12·5 per 1,000 as against 20·4 of the Guards *quartered in England* (Our Homes, page 13). Dr. A. Ransome reports (Health Lectures, 1875–'76, page 149) a case as late as 1861, where fearful lung disease broke out in some of the ships of the royal navy. The arrangements were actually such that only fourteen inches space was allowed to each hammock, and the air above the hammock was 8° to 10° hotter than below.*

The same evidence comes from the sedentary trades, some of which "afford experimental conditions for the development of disease"; from the cases of phthisis, or destructive lung disease, among cows in unventilated sheds (Parkes, page 162); from the higher rate of consumption in town as against village, and city as against town (Hirsch, page 213)—in each case the dearer lodging implying more overcrowding; from the outdoor treatments now recommended for consumptive patients; and from other sources.†

When we come to pneumonia, it is still the same poisons, we believe, which indirectly are at work. As in pulmonary con-

* The violence of so-called Russian influenza in America is probably to some extent the result of the breathing of highly impure air, which is so common in that country. We suspect that this disease is just one of the many forms of trouble which appear where people live in constant disregard of the purity of the air of their living-rooms. The subject demands attention from this point of view.

† There are many interesting points—such as the discussion as regards the effect of dampness of soil, and Hirsch's theory as regards the high Mexican plateaus—which have to be considered, but they do not seem to shake the main fact that impure air is the great ally of pulmonary consumption.

sumption the bacillus finds its food prepared for it in the unhealthy state of the blood and tissues—altered by the poisons that have been rebreathed from foul air—so also must it be in pneumonia; if we are to accept the statements made about the bacterium of pneumonia (Crookshank, page 273). Secondary pneumonia, which is a lung attack resulting from the poison in the system from such a fever as typhoid, throws some light upon this matter, and seems exactly to explain the origin of ordinary pneumonia. In ordinary pneumonia we believe that it would be found that the person attacked had been living in rooms where the air was tainted, had breathed consequently, again and again, the exhaled poisons, until these poisons had so altered the tissue as to allow the bacterium to form its lodgment; in other words, that he was as much "poisoned" as the person suffering from secondary pneumonia. Of course a slight chill, by arresting the action of the skin and thus increasing the poison in the system, is likely enough to be the immediate precursor of the attack by rendering the conditions still more favorable for the germ. Again, latent pneumonia in quite young children is sometimes masked (Quain, page 880) by the signs of the nervous disorder which precedes it. This nervous disorder tells the story. It is caused by the poisons which are acting on the system, and which at last produce the attack of pneumonia.*

It might, however, be urged that a person leading a healthy outdoor life might, after severe exposure, be attacked by pneumonia. Certainly, and in his case the attack would mean poisoning (that is, predisposing for the germ by poisoning) through the skin; just as in the case of the man living in bad air it would mean poisoning through the air taken into the lungs.

Now, granting that this is a true explanation, that pneumonia, or even common cold, is a case of poisoning, and only a case of cold in a secondary sense, it is worth noticing that the effect of these poisons must be felt in the throat and bronchial passages and lungs much more than in other organs. These poisons would cling to the sides of the throat and bronchial (and nasal) passages, and would often enter the lungs. In the case of persons living in foul air, these organs, being more exposed and in intimate contact with the poison, would probably be saturated with it, and therefore would be always prepared for disease. We can then under-

* If on the other hand it is believed that pneumonia can arise without the intervention of the bacterium, we must regard it as a case of direct instead of indirect poisoning. That there is such direct poisoning we know from those attacks of the liver and kidneys which follow a severe chill, and throw back the poisons, which should have been excreted by the skin, on to those organs. Parkes (p. 164) strongly believed that bronchitic affections are often produced from the breathing of foul air. He does not, however, as far as we are aware, enter into explanations.

stand at once why the leading symptoms of a cold are violent flow from the nose, sneezing, coughing, with the accumulation of phlegm, and painful soreness in the throat.* These symptoms become intelligible at once from the point of view of local poisoning, and we see in all the circumstances of a cold the "protective efforts" which Nature makes to eject the poison—of whatever kind it may be—from the parts which are specially attacked, just as we often see in diarrhœa the effort to get rid of an irritant, or in fever, with its rapid disintegration of tissue, of the poison that has attacked the system. Of course, as in pneumonia, some slight chill often immediately precedes the attack of cold—the chill, by its arrest of skin action, throwing more poison into the blood, which is sufficient to determine the attack in the predisposed part.

We believe, therefore, that few healthy persons would be subject to cold, unless they lived in impure air. With an old person, or a person in lowered health, it is different. A defective machinery for the circulation of the blood or for respiration might readily result in the waste-poisons being imperfectly separated from the blood, and thus such persons would live in the same state of blood-poisoning and preparation for attack as a young and healthy person does who constantly breathes bad air. Where we have cases of liver or kidney attack following upon a severe chill, we may suppose either that the poisons retained (or formed) near the surface of the body pass into the blood, and then act through the nervous centers upon those organs which happen to be specially susceptible; or that the poisons, imperfectly breathed out at the lungs, are carried directly to those organs.

We wish that it were possible to follow the subject further, but we have already overstepped the limits which the kindness of the editor has allowed. We can only say, in conclusion, that we are convinced that very grave issues are dependent upon the question of pure air in our houses. We suspect that not only liability to cold, but to gout, rheumatism, lumbago, neuralgia, some forms of headache, and many forms of nervous irritation are to be conquered by constantly giving lungs and skin a fair chance of getting rid of these poisons; we feel sure that the irritable temper that so often accompanies severe literary work, and at last ends in the "break down," must largely be put to the account of the impure air breathed through long hours; and we suspect

* The fact that the air that we breathe is delayed for some little time in the bronchia passages before reaching the lungs probably increases the local poisoning, and therefore the predisposition for attack by the germ of the parts when we breathe bad air. In this way perhaps the lungs are protected at the expense of the bronchial passages; and a cold is the violent occasional expurgation of those parts which are specially exposed to the poison.

that much of the intemperate drinking in towns results from the depressed feeling which follows work done under similar conditions. We think a great society should be formed to arouse the interest of all classes in this subject, and that inquiries should be made—the answers being published—as to the provision for fresh air existing in hotels, concert-rooms, theatres, schools, churches, etc. We are, both of us, opposed to action being taken through state inspectors. The present evil will never be really overcome until individual interest is aroused; and the state inspector does not develop individual interest. We shall be glad to communicate with any persons anxious to take steps in the matter, and shall hope to draw up a short paper containing a few practical suggestions of a simple nature. Meanwhile, without discussing systems of artificial ventilation, we say to everybody: "Live as much as you can with open windows, wearing whatever extra clothes are necessary. In this way you will turn the hours of your work to physical profit instead of to physical loss. If you can not bear an open window, even with an extra coat, and a rug over your knees, when you are sitting in a room, do the next best thing, which is, to throw the windows wide open—not a poor six inches—whenever you leave it, and thus get rid of the taint of the many dead bodies that we have breathed out from ourselves, and that hang like ghosts about our rooms. Smuts, as we confess, may be bad, but they are white as snow compared with impure air. Pay special attention to the constant exposure to pure air both of clothes and of bedding. Avoid chill, that is one form of poisoning. Avoid impure air, that is another and much more insidious form of poisoning."

Our present addresses are: Harold Wager, Yorkshire College, Leeds; and Auberon Herbert, Larichban, Cladich, Argyllshire.

Several gentlemen have been kind enough to read the foregoing paper, and to express the following opinions upon it. Sir Lyon Playfair writes:

I return your proof with only a few suggestions. The paper is a good exposition of air in its relations to public health, and is likely to be very useful. You ought to follow it up with another paper on water, and conclude with one on cleanliness. Pure air, pure water, and cleanliness, personal and objective, are the three great factors of public health, provided that people are adequately fed. Napoleon, reciting his long personal experiences at St. Helena, made a wise remark: "Life is a fortress which neither you nor I know anything about. Why throw obstacles in the way of its defense? Water, air, and cleanliness are the chief articles in my pharmacopœia." You and Mr. Wager have made an excellent beginning with air. Follow it up with essays on water and cleanliness, and then, as a veteran sanitary reformer, I will begin to think that my time for preaching is ended. I write this, withholding my judgment on certain special theories you have advanced.

Prof. Huxley writes:

When you insist upon the importance of fresh air—especially in combination with exercise—I go heartily with you. I have long been convinced (and to a great extent by personal experience) that what people are pleased to call "overwork" in a large proportion of cases means under-oxygenation and consequent accumulation of waste-matter, which operates as a poison. The "depression" of overworked nervous organization is very commonly the "oppression" of some physiological candle-snuff not properly burned.

Furthermore, it is highly probable that the decaying organic matter given off from the whole free surface of animal bodies, taken in conjunction with its microbial contents, is a source of danger, but whether directly or indirectly is a point about which I should not like to speak confidently.

The fact is, while the virtues of fresh air and the wisdom of physical purity as a prophylactic may be very confidently justified by experience, the theory of the subject is full of difficulties, and the present views of physiologists must be regarded as merely tentative hypotheses. I should not feel justified in putting the theoretical points you advance as safely established truths before the public. I began to mark some paragraphs I thought specially open to objection; but I can not go into the matter, as I am myself struggling out of the influenza poison, which afflicts one's brain with mere muddiness.

Dr. Clifford Allbutt writes:

Whether there be room for question in parts of your argument or not, it is in the main true, and your practical conclusions are as solidly true at they are impressive.

If any one doubt, let him try the marvelous recreation of a few nights camped out *sub dio* and be converted.

Moreover, the marvelous effects of an open-air life in the cure of such maladies as consumption are known of all men. But is it kind to tell us these dreadful things when we are helpless to amend them?

Your home solution of the problem is known to your friends, and is excellent in your circumstances, but is impossible in towns, where every inch of window means an inch of grime on walls, ceilings, and furniture. Not only so, but our big common dwelling-halls are gone, our high-backed chairs and settles are gone, our tapestry is gone, and air supplied in modern fashion *by slits or pipes* means "drafts."

Now, "drafts" will kill some of us as quickly as ptomaines and far more painfully.

Please write another paper to tell us what is to be done!

Dr. W. B. Cheadle writes:

I am sure that you are doing a valuable sanitary service in calling attention to the chronic poisoning by foul air which goes on so constantly without being realized in the homes of both rich and poor, and in business offices and in workshops.

The poor suffer from the small, ill-ventilated cubic space available for either sitting-rooms or bedrooms and the crowding of work-rooms; the better classes partly from the close offices in which some of them work, but chiefly from defective bedroom space and ventilation. Few people, I imagine, realize the fact that *about one third of their whole lives is spent in their bedrooms*, and that they pass this third part of their existence in an atmosphere so poisoned by organic matter that it would not be tolerated in a sitting-room for a moment. The amount of space allowed in bedrooms and dormitories is frequently altogether insufficient. Doors and windows are tightly closed, and there is practically little ventilation going on for six or eight hours of sleeping time, whereas in sitting-rooms the admission of air is promoted by persons passing in and out.

This steady nightly poisoning goes on in many public institutions, I am afraid, in the "houses" of some public schools, and the dormitories of charitable institutions. They are well ventilated during the day, closed at night, and the allowance of cubic space is quite insufficient to supply fresh air enough with the very small influx which can take place.

Night nurseries, again, especially in large towns, are liable to be grossly overcrowded. I have seen a small, low room in the attics of a London mansion used as a sleeping apartment for five or six children and a nurse which had not space or ventilation enough for two persons.

Without indorsing the whole of the pathology suggested in your excellent paper, I am sure you are right in attributing a large proportion of ill health, contagious disease, and especially the increased virulence of this, to air fouled by organic matter.

Prof. W. H. Flower writes:

I am not sufficiently acquainted with modern physiology to know whether all the scientific details of the paper are correct, but I quite agree with you in the very great importance of the subject being pressed home upon all classes. How, for instance, could people travel in a railway carriage with perhaps six or more companions shut up together for several hours, and insisting on *keeping all the windows closed*, as they often do, if they were made to realize that the air which they are breathing must necessarily be passing in and out of the lungs, not only of themselves, but of all their fellow-travelers as well, over and over again in the course of the journey, and each time becoming more and more contaminated?

I have always thought, though I have not medical experience enough to prove it, that the greater prevalence of tuberculosis and other lung disease in cold over warm climates is owing, not so much to difference of temperature, as to the fact that in the former there is a greater tendency to breathe impure air for the purpose of warmth. My theories on the subject are, however, rather staggered by the thought of rabbits, sand-martin, etc., passing a considerable part of their lives at the bottom of burrows, where anything like ventilation seems absolutely impossible, and yet remaining perfectly healthy.

Mr. Lawson Tait writes:

What can I add to an article, so lucidly written, save that I agree generally with it, and hope that it may be productive of great good, as it well may?

—*Contemporary Review.*

Dr. Junker expresses, in the narrative of his travels in Africa, a somewhat favorable opinion of the intellectual qualities of the negroes among whom he traveled, and pronounces them capable of higher moral development. He everywhere found the upper classes, princes and nobles, the most highly endowed with intellectual qualities. This he attributes to the fact that the negro ruler is compelled to think and act in his capacity of judge, lawgiver, and captain. He notices, too, the wonderful fluency of speech acquired from the custom of making long orations, embellished with simile and metaphor, in their public assemblies.

A DESERT FRUIT.

By GRANT ALLEN.

WHO knows the Mediterranean, knows the prickly pear. Not that that quaint and uncanny-looking cactus, with its yellow blossoms and bristling fruits that seem to grow paradoxically out of the edge of thick, fleshy leaves is really a native of Italy, Spain, and North Africa, where it now abounds on every sun-smitten hillside. Like Mr. Henry James and Mr. Marion Crawford, the Barbary fig, as the French call it, is, in point of fact, an American citizen, domiciled and half naturalized on this side of the Atlantic, but redolent still at heart of its Columbian origin. Nothing is more common, indeed, than to see classical pictures of the Alma-Tadema school—not, of course, from the brush of the master himself, who is impeccable in such details, but fair works of decent imitators—in which Caia or Marcia leans gracefully in her white stole on one pensive elbow against a marble lintel, beside a court-yard decorated with a Pompeiian basin, and overgrown with prickly pear or "American aloes." I need hardly say that, as a matter of plain historical fact, neither cactuses nor agaves were known in Europe till long after Christopher Columbus had steered his wandering bark to the sandy shores of Cat's Island in the Bahamas. (I have seen Cat's Island with these very eyes, and can honestly assure you that its shores *are* sandy.) But this is only one among the many pardonable little inaccuracies of painters, who thrust scarlet geraniums from the Cape of Good Hope into the fingers of Aspasia, or supply King Solomon in all his glory with Japanese lilies of the most recent introduction.

At the present day, it is true, both the prickly-pear cactus and the American agave (which the world at large insists upon confounding with the aloe, a member of a totally distinct family) have spread themselves in an apparently wild condition over all the rocky coasts both of southern Europe and of northern Africa. The alien desert weeds have fixed their roots firmly in the sun-baked clefts of Ligurian Apennines; the tall candelabrum of the Western agave has reared its great spike of branching blossoms (which flower, not once in a century, as legend avers, but once in some fifteen years or so) on all the basking hillsides of the Mauritanian Atlas. But for the origin, and therefore for the evolutionary history, of either plant, we must look away from the shore of the inland sea to the arid expanse of the Mexican desert. It was there, among the sweltering rocks of the Tierras Calientes, that these ungainly cactuses first learned to clothe themselves in prickly mail, to store in their loose tissues an abundant supply of sticky moisture, and to set at defiance the persistent attacks of all external enemies. The prickly pear, in fact, is a typical instance of a desert plant, as the camel is a typical instance of a desert animal. Each lays itself out to endure the long droughts of its almost rainless habitat by drinking as much as it can when opportunity offers, hoarding up the superfluous water for future use, and economizing evaporation by every means in its power.

If you ask that convenient fiction, the Man in the Street, what sort of plant a cactus is, he will probably tell you it is all leaf and no stem, and each of the leaves grows out of the last one. Whenever we set up the Man in the Street, however, you must have noticed we do it in order to knock him down again like a nine-pin next moment: and this particular instance is no exception to the rule; for the truth is that a cactus is practically all stem and no leaves, what looks like a leaf being really a branch sticking out at an angle. The true leaves, if there are any, are reduced to mere spines or prickles on the surface, while the branches, in the prickly-pear and many of the ornamental hot-house cactuses, are flattened out like a leaf to perform foliar functions. In most plants, to put it simply, the leaves are the mouths and stomachs of the organism; their thin and flattened blades are spread out horizontally in a wide expanse, covered with tiny throats and lips which suck in carbonic acid from the surrounding air, and disintegrate it in their own cells under the influence of sunlight. In the prickly pears, on the contrary, it is the flattened stem and branches which undertake this essential operation in the life of the plant—the sucking-in of carbon and giving-out of oxygen, which is to the vegetable exactly what the eating and digesting of food is to the animal organism. In their old age, however, the stems of the prickly pear display their true character by becoming woody in texture and losing their articulated leaf-like appearance.

Everything on this earth can best be understood by investigating the history of its origin and development, and in order to understand this curious reversal of the ordinary rule in the cactus tribe we must look at the circumstances under which the race was evolved in the howling waste of American deserts. (All deserts have a prescriptive right to howl, and I wouldn't for worlds deprive them of the privilege.) Some familiar analogies will help us to see the utility of this arrangement. Everybody knows our common English stone-crops—or if he doesn't he ought to, for they are pretty and ubiquitous. Now, stone-crops grow for the most part in chinks of the rock or thirsty, sandy soil; they are essentially plants of very dry positions. Hence they have thick and succulent little stems and leaves, which merge into one another by imperceptible gradations. All parts of the plant alike are stumpy, green, and cylindrical. If you squash them with your finger and thumb you find that, though the outer skin or epidermis is thick and firm, the inside is sticky, moist, and jelly-like. The reason for all this is plain: the stone-crops drink greedily by their roots whenever they get a chance, and store up the water so obtained to keep them from withering under the hot and pitiless sun that beats down upon them for hours in the baked clefts of their granite matrix. It's the camel trick over again. So leaves and stems grow thick and round and juicy within; but outside they are inclosed in a stout layer of epidermis, which consists of empty glassy cells, and which can be peeled off or flayed with a knife like the skin of an animal. This outer layer prevents evaporation, and is a marked feature of all succulent plants which grow exposed to the sun on arid rocks or in sandy deserts.

The tendency to produce rounded stems and leaves, little distinguishable from one another, is equally noticeable in many seaside plants which frequent the strip of thirsty sand beyond the reach of the tides. That belt of dry beach that stretches between high-water mark and the zone of vegetable mold is to all intents and purposes a miniature desert. True, it is watered by rain from time to time; but the drops sink in so fast that in half an hour, as we know, the entire strip is as dry as Sahara again. Now, there are many shore weeds of this intermediate sand-belt which mimic to a surprising degree the chief external features of the cactuses. One such weed, the common salicornia, which grows in sandy bottoms or hollows of the beach, has a jointed stem, branched and succulent, after the true cactus pattern, and entirely without leaves or their equivalents in any way. Still more cactus-like in general effect is another familiar English seaside weed, the kali or glasswort, so called because it was formerly burned to extract the soda. The glasswort has leaves, it is true, but they are thick and fleshy, continuous with the stem, and each one terminating in a sharp, needle-like spine, which effectually protects the weed against all browsing aggressors.

Now, wherever you get very dry and sandy conditions of soil, you get this same type of cactus-like vegetation—*plantes grasses*, as the French well call them. The species which exhibit it are not necessarily related to one another in any way; often they belong to most widely distinct families; it is an adaptive resemblance alone, due to similarity of external circumstances only. The plants have to fight against the same difficulties, and they adopt for the most part the same tactics to fight them with. In other words, any plant, of whatever family, which wishes to thrive in desert conditions, must almost as a matter of course become thick and succulent, so as to store up water, and must be protected by a stout epidermis to prevent its evaporation under the fierce heat of the sunlight. They do not necessarily lose their leaves in the process; but the jointed stem usually answers the purpose of leaves under such conditions far better than any thin and exposed blade could do in the arid air of a baking desert. And therefore, as a rule, desert plants are leafless.

In India, for example, there are no cactuses. But I wouldn't advise you to dispute the point with a peppery, fire-eating Anglo-Indian colonel. I did so once, myself, at the risk of my life, at a *table d'hôte* on the Continent; and the wonder is that I'm still alive to tell the story. I had nothing but facts on my side, while the colonel had fists, and probably pistols. And when I say no cactuses, I mean, of course, no indigenous species; for prickly pears and epiphyllums may naturally be planted by the hand of man anywhere. But what people take for thickets of cactus in the Indian jungle are really thickets of cactus-like spurges. In the dry soil of India, many spurges grow thick and succulent, learn to suppress their leaves, and assume the bizarre forms and quaint jointed appearance of the true cactuses. In flower and fruit, however, they are euphorbias to the end; it is only in the thick and fleshy stem that they resemble their nobler and more beautiful Western rivals. No true cactus grows truly wild anywhere on earth except in America. The family was developed there, and, till man transplanted it, never succeeded in gaining a foothold elsewhere. Essentially tropical in type, it was provided with no means of dispersing its seeds across the enormous expanse of intervening ocean which separated its habitat from the sister continents.

But why are cactuses so almost universally prickly? From the grotesque little melon-cactuses of our English hot-houses to the huge and ungainly monsters which form miles of hedgerows on Jamaican hillsides, the members of this desert family are mostly distinguished by their abundant spines and thorns, or by the irritating hairs which break off in your skin if you happen to brush incautiously against them. Cactuses are the hedgehogs of the vegetable world; their motto is *Nemo me impune lacessit.* Many a time in the West Indies I have pushed my hand for a second into a bit of tangled "bush," as the negroes call it, to seize some rare flower or some beautiful insect, and been punished for twenty-four hours afterward by the stings of the almost invisible and glass-like little cactus-needles. When you rub them they only break in pieces, and every piece inflicts a fresh wound on the flesh where it rankles. Some of the species have large, stout prickles; some have clusters of irritating hairs at measured distances; and some rejoice in both means of defense at once, scattered impartially over their entire surface. In the prickly pear, the bundles of prickles are arranged geometrically with great regularity in a perfect quincunx. But that is a small consolation indeed to the reflective mind when you've stung yourself badly with them.

The reason for this bellicose disposition on the part of the cactuses is a tolerably easy one to guess. Fodder is rare in the desert. The starving herbivores that find themselves from time to time belated on the confines of such thirsty regions would seize with avidity upon any succulent plant which offered them food and drink at once in their last extremity. Fancy the joy with which a lost caravan, dying of hunger and thirst in the byways of Sahara, would hail a great bed of melons, cucumbers, and lettuces! Needless to say, however, under such circumstances melon, cucumber, and lettuce would soon be exterminated; they would be promptly eaten up at discretion without leaving a descendant to represent them in the second generation. In the ceaseless war between herbivore and plant, which is waged every day and all day long the whole world over with far greater persistence than the war between carnivore and prey, only those species of plant can survive in such exposed situations which happen to develop spines, thorns, or prickles as a means of defense against the mouths of hungry and desperate assailants.

Nor is this so difficult a bit of evolution as it looks at first sight. Almost all plants are more or less covered with hairs, and it needs but a slight thickening at the base, a slight woody deposit at the point, to turn them forthwith into the stout prickles of the rose or the bramble. Most leaves are more or less pointed at the end or at the summits of the lobes; and it needs but a slight intensification of this pointed tendency to produce forthwith the sharp defensive foliage of gorse, thistles, and holly. Often one can see all the intermediate stages still surviving under one's very eyes. The thistles themselves, for example, vary from soft and unarmed species which haunt out-of-the-way spots beyond the reach of browsing herbivores, to such trebly-mailed types as that enemy of the agricultural interest, the creeping thistle, in which the leaves continue themselves as prickly wings down every side of the stem, so that the whole plant is amply clad from head to foot in a defensive coat of fierce and bristling spear-heads. There is a common little English meadow weed, the rest-harrow, which in rich and uncropped fields produces no defensive armor of any sort; but on the much-browsed-over suburban commons and in similar exposed spots, where only gorse and blackthorn stand a chance for their lives against the cows and donkeys, it has developed a protected variety in which some of the branches grow abortive, and end abruptly in stout spines like a hawthorn's. Only those rest-harrows have there survived in the sharp struggle for existence which happened most to baffle their relentless pursuers.

Desert plants naturally carry this tendency to its highest point of development. Nowhere else is the struggle for life so fierce; nowhere else is the enemy so goaded by hunger and thirst to desperate measures. It is a place for internecine warfare. Hence, all desert plants are quite absurdly prickly. The starving herbivores will attack and devour under such circumstances even thorny weeds, which tear or sting their tender tongues and palates, but which supply them at least with a little food and moisture: so the plants are compelled in turn to take almost extravagant precautions. Sometimes the leaves end in a stout dagger-like point, as with the agave, or so-called American aloe; sometimes they are reduced to mere prickles or bundles of needle-like spikes; sometimes they are suppressed altogether, and the work of defense is undertaken in their stead by irritating hairs intermixed with caltrops of spines pointing outward from a common center in every direction. When one remembers how delicately sensitive are the tender noses of most browsing herbivores, one can realize what an excellent mode of defense these irritating hairs must naturally constitute. I have seen cows in Jamaica almost maddened by their stings, and even savage bulls will think twice in their rage before they attempt to make their way through the serried spears of a dense cactus hedge. To put it briefly, plants have survived under very arid or sandy conditions precisely in proportion as they displayed this tendency toward the production of thorns, spines, bristles, and prickles.

It is a marked characteristic of the cactus tribe to be very tenacious of life, and, when hacked to pieces, to spring afresh in full vigor from every scrap or fragment. True vegetable hydras, when you cut down one, ten spring in its place; every separate morsel of the thick and succulent stem has the power of growing anew into a separate cactus. Surprising as this peculiarity seems at first sight, it is only a special desert modification of a faculty possessed in a less degree by almost all plants and by many animals. If you cut off the end of a rose branch and stick it in the ground under suitable conditions, it grows into a rose tree. If you take cuttings of scarlet geraniums or common verbenas, and pot them in moist soil, they bud out apace into new plants like their parents. Certain special types can even be propagated from fragments of the leaf; for example, there is a particularly vivacious begonia off which you may snap a corner of one blade, and hang it up by a string from a peg or the ceiling, when, hi presto! little begonia plants begin to bud out incontinently on every side from its edges. A certain German professor went even further than that: he chopped up a liverwort very fine into vegetable mincemeat, which he then spread thin over a saucerful of moist sand, and lo! in a few days the whole surface of the mess was covered with a perfect forest of sprouting little liverworts. Roughly speaking, one may say that every fragment of every organism has in it the power to rebuild in its entirety another organism like the one of which it once formed a component element.

Similarly with animals. Cut off a lizard's tail, and straightway a new tail grows in its place with surprising promptitude. Cut off a lobster's claw, and in a very few weeks that lobster is walking about airily on his native rocks, with two claws as usual. True, in these cases the tail and the claw don't bud out in turn into a new lizard or a new lobster. But that is a penalty the higher organisms have to pay for their extreme complexity. They have lost that plasticity, that freedom of growth, which characterizes the simpler and more primitive forms of life; in their case the power of producing fresh organisms entire from a single fragment, once diffused equally over the whole body, is now confined to certain specialized cells which, in their developed form, we know as seeds or eggs. Yet, even among animals, at a low stage of development, this original power of reproducing the whole from a single part remains inherent in the organism; for you may chop up a fresh-water hydra into a hundred little bits, and every bit will be capable of growing afresh into a complete hydra.

Now, desert plants would naturally retain this primitive tendency in a very high degree; for they are specially organized to resist drought—being the survivors of generations of drought-proof ancestors—and, like the camel, they have often to struggle on through long periods of time without a drop of water. Exactly the same thing happens at home to many of our pretty little European stone-crops. I have a rockery near my house overgrown with the little white sedum of our gardens. The birds often pick off a tiny leaf or branch; it drops on the dry soil, and remains there for days without giving a sign of life. But its thick epidermis effectually saves it from withering; and as soon as rain falls, wee white rootlets sprout out from the under side of the fragment as it lies, and it grows before long into a fresh small sedum plant. Thus, what seem like destructive agencies themselves, are turned in the end by mere tenacity of life into a secondary means of propagation.

That is why the prickly pear is so common in all countries where the climate suits it, and where it has once managed to gain a foothold. The more you cut it down, the thicker it springs; each murdered bit becomes the parent in due time of a numerous offspring. Man, however, with his usual ingenuity, has managed to best the plant, on this its own ground, and turn it into a useful fodder for his beasts of burden. The prickly pear is planted abundantly on bare rocks in Algeria, where nothing else would grow, and is cut down when adult, divested of its thorns by a rough process of hacking, and used as food for camels and cattle. It thus provides fresh moist fodder in the African summer when the grass is dried up and all other pasture crops have failed entirely.

The flowers of the prickly pear, as of many other cactuses, grow apparently on the edge of the leaves, which alone might give the observant mind a hint as to the true nature of those thick and flattened expansions. For, whenever what look like leaves bear flowers or fruit on their edge or midrib, as in the familiar instance of butcher's broom, you may be sure at a glance they are really branches in disguise masquerading as foliage. The blossoms in the prickly pear are large, handsome, and yellow; at least, they would be handsome if one could ever see them, but they're generally covered so thick in dust that it's difficult properly to appreciate their beauty. They have a great many petals in numerous rows, and a great many stamens in a rosette in the center; and to the best of my knowledge and belief, as lawyers put it, they are fertilized for the most part by tropical butterflies; but on this point, having observed them but little in their native habitats, I speak under correction.

The fruit itself, to which the plant owes its popular name, is botanically a berry, though a very big one, and it exhibits in a highly specialized degree the general tactics of all its family. As far as their leaf-like stems go, the main object in life of the cactuses is—not to get eaten. But when it comes to the fruit, this object in life is exactly reversed; the plant desires its fruit to be devoured by some friendly bird or adapted animal, in order that the hard little seeds buried in the pulp within may be dispersed for germination under suitable conditions. At the same time, true to its central idea, it covers even the pear itself with deterrent and prickly hairs, meant to act as a defense against useless thieves or petty depredators, who would eat the soft pulp on the plant as it stands (much as wasps do peaches) without benefiting the species in return by dispersing its seedlings. This practice is fully in accordance with the general habit of tropical or subtropical fruits, which lay themselves out to deserve the kind offices of monkeys, parrots, toucans, hornbills, and other such large and powerful fruit-feeders. Fruits which arrange themselves for a *clientèle* of this character have usually thick or nauseous rinds, prickly husks, or other deterrent integuments; but they are full within of juicy pulp, imbedding stony or nutlike seeds, which pass undigested through the gizzards of their swallowers.

For a similar reason, the actual prickly pears themselves are attractively colored. I need hardly point out, I suppose, at the present time of day, that such tints in the vegetable world act like the gaudy posters of our London advertisers. Fruits and flowers which desire to attract the attention of beasts, birds, or insects, are tricked out in flaunting hues of crimson, purple, blue, and yellow; fruits and flowers which could only be injured by the notice of animals are small and green, or dingy and inconspicuous.—*Longman's Magazine.*

SKETCH OF ALESSANDRO VOLTA.

VOLTA'S title to be remembered rests chiefly upon his application of the discovery of the production of electricity by contact, which has been fruitful and continues to be fruitful of results of the greatest importance in the progress of research in the domains of physical forces and of the constitution of matter, and is one of the most potent instruments in the hands of students for enlarging the boundaries of their knowledge of the material world.

ALESSANDRO VOLTA was born at Como, Italy, February 19, 1745, and died in the same place March 5, 1827. He began his studies in the public school of his native town, where he distinguished himself among his fellow-pupils by his capability and his assiduity at work. A passage in his first scientific paper shows that when he was eighteen years old he had been engaged in a correspondence with the Abbé Nollet on subjects relating to electricity. At nineteen years of age he composed a poem, in Latin, which has never been published, in which some of the more important discoveries of the time were described. In 1774 he was appointed to the chair of Physics in the Royal School at Como, for which his first two scientific papers—on the Attractive Force of the Electric Fire, and on the Method of constructing the New Electrical Machine—seem to have been among his strongest recommendations. He went out of Italy for the first time in 1777, to make a visit of several weeks in Switzerland, where he met Haller at Berne, Voltaire at Ferney, and Benjamin de Saussure at Geneva. The story of this excursion was related in a book * which was published at Milan in 1827. In 1779 Volta was made a professor in the University of Pavia, where his instructions were attended by throngs of interested youths from all countries, proud to be his pupils, and where he continued till 1819, when he retired to spend the rest of his days in his native town. In 1782 he made what appears to have been the longest journey of his life, in company with the surgeon Scarpa, and visited the capitals of Germany, Holland, England,

* *Relazione del Prof. Volta di un suo Viaggio letterario nel Swizzera.*

and France, making the acquaintance of the most distinguished men of science in those countries. Volta's first scientific paper, on the Attractive Force of the Electric Fire (*De Vi attractiva Ignis electrici*), which was addressed in 1769 to P. Beccaria, is described by M. Biot as giving only an imperfect explanation of electric phenomena, and as illustrating the characteristic trait of his mind, which led him rather to sure deductions from facts which he could experimentally follow out than to the formation of sound general theories. That part of the paper in which he showed the application of his theory to the generation of electricity is mentioned by Prof. Arthur Schuster as being of historical importance, because in it can be traced the germ of many future discoveries. He supposed that all bodies in the natural state contain electricity in such proportions that they are in electrical equilibrium, and that this was shown in the experimental results obtained by rubbing one metal with another. But when bodies are brought into close contact, as in friction, he considered that the attractions of electricity and matter might alter, according to Boscovich's theory that attraction and repulsion alternate at short distances, and that a new equilibrium would establish itself. He expressed a belief that a disturbance of electrical equilibrium takes place during the progress of chemical action, in which the particles of matter change their position; attributed the want of proof of the fact to experimental difficulties; and hoped that he would succeed in obtaining evidence of it; and he thought that atmospheric electricity might be accounted for in accordance with these views.

In his second paper he attempted to explain electrical insulation by the supposition of a repulsion between the insulating matter and electricity. His experiments, made in 1775, on the insulating property which wood acquires when impregnated with oil, led to the construction of the electrophorus, an apparatus which acts as a permanent and inexhaustible source whence electricity can be drawn at will. A letter of Volta's to Priestley is preserved, dated June 10, 1775, announcing the construction of this instrument, and asking the English chemist, as the historian of electricity, how far the discovery was new. Volta's experiments on the electrostatic capacity of conductors, described in a letter to De Saussure in 1778, were in advance of anything that had been published up to that time, although Cavendish had already experimented on the subject; but Cavendish's results were not published for a long time afterward. Volta's ingenious efforts, pursued continuously, to improve the electrophorus, led up to the discovery of the electric condenser, the description of which, and the account of its applications to the study of electrical phenomena, were published in the Philosophical Transactions of 1782. By means of this apparatus, according to M. Biot, the smallest quantities of electricity, emanating from a source that can reproduce them constantly as they are taken away, were fixed and accumulated in a conductive plate by virtue of the momentary attraction of electricity of a different denomination, from which they were withdrawn when it was desired to make them perceptible and to subject them to observation. During this time Volta was still trying to find signs of electricity during the processes of evaporation and boiling and changes of temperature; and he finally thought he had discovered electrical effects during the evaporation of water—in the phenomena which are now attributed to the friction of the vapor. These results suggested the closer examination of the phenomena of atmospheric electricity, concerning which—*Meteorologia Elettrica*—he wrote a number of letters to Lichtenberg. Two of his letters related to electrical measurements and the straw electrometer, in which the angle of divergence of two electrified straws was measured. He also, according to Prof. Schuster, constructed the first absolute electrometer, and compared his other instruments with it, so that it would be possible now to refer all his measurements to absolute units. His electrometer consisted of a balance, one pane of which was a flat round disk. Below this disk was placed a large parallel plate, conducted away to earth, while stops were arranged so that the disk could not approach nearer than within two inches of the plate. In the unelectrified state the balance was in a condition of equilibrium. When the disk was electrified, it was attracted toward the plate, but kept at its proper distance by the stops; weights were then added in the other plate of the balance until the disk was pulled away from the stops. The letters also contain discussions on the action of points and flames in discharging electricity. To Volta are further owing the invention of the electric eudiometer and of the inflammable air or hydrogen lamp. Prof. Schuster regards as worthy of mention also Volta's investigations on gas analysis and his paper on the expansion of gases by heat. He showed the causes which had led different experimenters to inconsistent results, and established independently what is now known as the law of Charles.

Volta's crowning discovery of the voltaic pile grew out of researches which were suggested by Galvani's famous experiment with the frog. Galvani attributed the phenomena which he observed in the frog's muscle to a new kind of electricity, which he called animal electricity. Volta, following up his experiments with more accurate instruments and by a more careful method, came to a different conclusion. He noticed that the convulsions of the frog's muscle were very rarely produced when a single metal was used, and then only under conditions of extreme irritability; but that they occurred with certainty and continued for some time when he had a circuit of two heterogeneous metals. From this he concluded that the exciting principle resided in the metals; and as this principle was evidently electric, since its transmission was interrupted by all the substances that intercept the electric current, that the mere contact of heterogeneous metals would develop a quantity of electricity which, though weak, would be competent when transmitted through the organs of the frog, completing the chain, to produce the convulsions. He demonstrated the verity of his induction by positive and direct experiments through which this weak electricity was accumulated in his condenser and made perceptible. He further found that this mode of development of electricity by simple contact was applicable, not to metallic bodies only, but to all heterogeneous bodies, although with different degrees of intensity according to their several natures; and having discovered the general principle, which had not been suspected before, he applied it to the construction of a new apparatus which was capable of producing infinitely augmented effects. In order to increase the intensity of his contact electricity, he enlarged the number of the metallic disks or plates he employed to produce it. His efforts were for some time unfruitful. He remarked that when he placed a disk of copper between two disks of zinc, or a disk of zinc between two disks of copper, the electrization was neutralized. He then thought to separate the disks by a conducting body, and found that by placing moistened paper between two double metallic disks the electric intensity was doubled. It was after that easy, by increasing the number of disks and separating them by moistened cloth, to obtain an electric intensity corresponding with the number of pairs. Concerning this series of experiments, he wrote in a letter to a French philosopher, M. La Metherie, which was published in the *Journal de Physique* in 1801: "Having found what degree of electricity I obtained with one of these metallic couples, by the aid of the condenser I use, I proceed to show that with two, three, or four couples, properly arranged—that is, all turned in the same direction and communicating with one another by as many moist layers (which are required, as I have shown, to prevent actions in the contrary direction)—we have double, triple, quadruple, etc.; so that if with a single couple we succeed in electrifying the condenser to the point of its causing the electrometer to indicate, for example, three degrees, with two couples we will get six, with three nine, and with four twelve degrees, if not exactly, nearly so."

Although opinions may differ as to the interpretation of some of the experiments, Prof. Schuster remarks, in the Encyclopædia Britannica, that there is not much in Volta's writings on the subject which could be called incorrect, even at the present day. His first communication concerning his researches on the development of electricity by contact was addressed to the Royal Society of England in 1792. In his account of the pile, addressed to Sir J. Banks, and read before the Royal Society in June, 1800, Volta described some of the experimental results obtained with it, and showed that all the effects produced were the same as those which could be obtained from electrical machines, and that therefore galvanism and electricity were identical.

Volta received the Copley medal of the Royal Society in 1791 or 1792. In 1801 he visited Paris, upon the invitation of the First Consul, and there repeated his experiments on the development of electricity by contact before a commission of the Institute. According to M. Arago's story of the meeting, the First Consul desired to attend in person the session at which the commissioners were to present a detailed account of the grand phenomena. Hardly had their conclusions been read, when he proposed to decree a gold medal to Volta as a testimonial of the appreciation in which he was held by French men of science. Custom and the academical regulations hardly permitted compliance with this demand; but the regulations were made for ordinary conditions, and the professor from Pavia had placed himself beyond their line. The medal was voted by acclamation; and on the same day Volta was given, by order of Napoleon, the sum of two thousand francs from the state funds toward the expenses of his journey. In 1808 he was made one of the eight foreign associates designated by the Institute. He was also decorated with the crosses of the Legion of Honor and of the Iron Crown; was named a member of the Council of Lyon; and in 1810 was raised to the dignity of a senator of the kingdom of Italy, with the title of count. When, in 1804, he desired to retire from the university, the Emperor said he could not consent to such a step. "If Volta's functions as a professor are fatiguing to him, let them be reduced. Let him, if he will, have to give only one lesson a year; but the University of Pavia would be struck to the heart on the day that I should permit so illustrious a name to disappear from the list of its members. Besides," he added, "a good general ought to die on the field of battle." So Volta continued to attract young men to his lectures. In 1815 the Emperor of Austria made Volta Director of the Philosophical Faculty of Padua.

Sir Humphry Davy, who visited Volta at Milan in 1814, when he was sixty-nine years old, found him a man well advanced in age and in poor health. "His conversation was not brilliant; his views were narrow, but marked by considerable ingenuity. His manners were of perfect simplicity. He had not the air of a courtier, or even that of a man who had lived in the world. In general, Italian men of science are without affectation in their manners, although they lack grace and dignity." Arago draws a somewhat more favorable portrait of him, saying, "Volta was tall, and had noble and regular features like those of an ancient statue; a broad forehead, which laborious thought had deeply furrowed, a face on which were painted alike calmness of soul and a penetrating intellect. . . . His manners always retained traces of rustic habits contracted during his youth. Many persons recollect having seen Volta, when in Paris, going daily to the bake-shop, and afterward eating in the streets the bread he had bought there, without imagining that he was an object of remark. . . . Strong and quick intelligence, large and just ideas, and an affectionate and sincere character were his dominant qualities. Ambition, the thirst for gold, the spirit of rivalry, dictated none of his actions. With him the love of learning, the only passion which he had experienced, continued free from all worldly alliance."

A collection of Volta's writings, drawn from the journals and periodical transactions in which they first appeared, was published at Florence in 1816, in five volumes. It is pronounced valuable by M. Biot, on account of the fidelity with which we may trace in it the succession of his ideas on the most important subjects in which he was interested during his long career.

There are still natives in the Melanesian Islands, Dr. Codrington relates in his studies of their anthropology and folk lore, who remember when a white man was first seen and what he was taken to be. When Bishop Patteson landed at Mota, for instance, he entered an empty house, the owner of which had lately died. This settled the question: he was the ghost of the late householder. The visitor, especially if he is a whaler, is soon discovered by his behavior not to be a ghost, but he can not be a living man, for in that case he would be black; he is, therefore, probably a mischievous spirit, bringing disease and disaster. Shooting at these spirits could not do them much harm, they not being men, but might drive them away. Consequently, in this belief, the Santa Cruz people shot at Bishop Patteson's party in 1864.

Mr. Jones's report in the British Association on the Elbolton Cave, near Skipton, was of unusual interest. Long-headed human skulls were found with burned bones and charcoal in the upper stratum, associated with domestic animals and pottery ornamented with diamond and herring-bone patterns; while at a much lower level—from thirteen to fifteen feet below the floor—there were round skulls, much more decayed, in connection with ruder and thicker pottery than has been found in any other part of the cave. No flints or metal have been found, and bone pins and other worked bone are the only human implements hitherto discovered. The remains of bear and hare have been found in cave-earth below this level.

CORRESPONDENCE.

SURVIVAL OF ANCESTRAL TRAITS.

Editor Popular Science Monthly:

SIR: Being greatly interested in the subject treated by Dr. Louis Robinson in the March Popular Science Monthly, and having had some opportunity to study infant life, I would like to call attention to some observations which I have made in that line and which may interest others.

The toes of the new-born babe are proportionately longer and more flexible than are those of the adult, and instinctively close around the finger or any object not cold enough to repel them which may be placed under them, thus approaching somewhat the type of a probable tree-climbing ancestor.

Still earlier ancestry is strikingly suggested by the nails of the young infant. The long, tapered, and curved finger-nails, so commonly considered refined, at this age exhibit a degree of elegance leaving nothing to be desired. Should the transformation in this feature after birth proceed at the same rate that it now does, but in the inverse direction, the results might startle those who pursue nail culture as a fine art. It is not uncommon to see the growth of nail beyond the new babe's finger so long and so sharply curved that the lateral edges almost meet, showing a decided resemblance to a claw. This is most particularly the case with the little finger, which maintains the same degree of difference from the others as may be observed on the hand of the adult. I have never seen an exception in persons of any age but that the nail of the little finger —the *least used* of all the fingers—most nearly approaches (probably retains through neglect) the proportions of a claw. The third finger (not counting the thumb) commonly shows an intermediate degree of form and service.

As the consciousness of the outside world and of their relations to it dawns upon the youngsters, there is something in their manner akin to alertness. I have often seen babies four or five months old, while making animated efforts toward the acquaintance of some simple object, such as a drawer-knob, spindle of a bedstead, or the like, suddenly turn from it with a frightened look as if some slight sound or sensation which they had associated with it had transformed it into an enemy. Another baby propensity which can not be accounted for in its individual training is the disposition, on being startled (not greatly agitated), to press the body against the nurse, drop the face against her, and for an instant remain *perfectly quiet*, not breathing apparently, the quiet being followed by a deep-drawn breath. When we need not go back of the age of man to find these instincts operating as important preservative factors, it is not unreasonable to read therein relationship to the lower orders in which they operate yet more prominently, as illustrated by the case of the calf and colt in Dr. Robinson's article.

Fear is the first and for some time the only emotion whose workings I perceive in the infant mind. Anger comes next.

There are some indications that the sense of smell is at birth more strongly developed than are the senses which come to be vastly more important to the man—e. g., a certain odorous remedy which had been constantly used on the inflamed breast of a mother was found to be a sure reminder to the babe (then under five weeks old) that it was dinner-time. A drop of it placed on the babe's upper lip would immediately start her to reaching and nestling for her food. I have never tried but the one case.

What in ancestral habit or condition (or is there anything now in animal life analogous to it?) will account for the *position* of the infant thumb, which is so peculiar to this age and so persistent, the thumb being much bent at the first joint and lying close to the palm of the hand? Apparently it is the last of the five fingers to yield to the will of the babe in grasping things, acting rather as an obstruction than a help for six, seven, or eight months. L. H. C.

MINNEAPOLIS, MINN., *March* 5, 1892.

SAVAGE SUPERSTITIONS.

Editor Popular Science Monthly:

SIR: In the November issue of the Monthly (vol. xl, page 103) some facts are cited as proving that "the savage is convinced that an injury done to the image is inflicted upon the original." This reminds me of an observation I read some years ago in Biard's Viaje al Brasil (La Vuelta al Mundo, 1863, page 212). This traveler relates that some of his Indian models would run away as soon as he tried to make their portraits. It was discovered that an Indian servant of his had told them that in the land of the white men there were many individuals without a head, and that the traveler was charged with collecting as many heads as he could, so that the imprudent Indian who would serve him as a model would after some time find that his head abandoned him and went to place itself upon the shoulders of the white man for whom it was destined.

Respectfully yours,

A. RUIZ CADALSO.

HAVANA, CUBA, *March* 1, 1892.

EDITOR'S TABLE.

MEANS OF INTELLECTUAL CULTURE.

THE question of the just distribution of material wealth is one which to-day is engaging many minds, and which in some quarters is being discussed with no small amount of passion. We are not aware, however, that there is any theory now before the world in the light of which any material change could hopefully be made in the existing structure of society. The only theory or doctrine, so far as we can see, that is at all hopeful is that which proclaims that governments should not, by arbitrary interferences with the course of trade, do anything to promote inequalities of fortune. It seems to us possible, however, and not only possible but probable, that if we would concern ourselves more than we do with the question of a better distribution of culture or intellectual wealth, some of the difficulties that beset the other question might be sensibly diminished. If culture means anything, it means adequate knowledge and orderly thought, and it is difficult to see how, if there were a marked improvement in the general intellectual condition of a community—a raising of the level of its culture—there should not also be an improvement in its economic condition. An increase in culture of the right sort would mean an abatement of the feverish thirst for wealth which is a characteristic of our time, and a more or less general adoption of more rational modes of life. It would mean the development of a higher public opinion and the purification of political methods and principles. It would mean an elevation of social manners, and would call into existence a finer individual self-respect. It would make people intolerant of abuses that admitted of remedy and more sensitive to every form of social injustice. In a word, as the inner man was renewed from day to day, so he would renew his environment, justifying anew the words of the poet Spenser:

> "For of the soul the body form doth take,
> For soul is form and doth the body make."

What are the means of culture at our disposal at the present day? We have first of all the public schools. Of these as instruments of culture in any high sense it is impossible to speak enthusiastically. It is not because they deal only with the elements of knowledge, because much of true culture could be imparted in connection with "the three r's." It is simply because they are not to any wide extent dominated by the spirit of culture, but on the whole tend rather to antagonize culture by attaching vulgar ideas of mere personal gain to the acquisition of knowledge. In saying this we are fully prepared to make all needful exceptions. Here and there, no doubt, teachers are to be found who, with high aims, throw their whole soul into their work, and thus confer a benefit on the community which, in most cases, is far from being adequately recognized or compensated.

Then we have our high schools, colleges, and universities. Here, no doubt, much excellent work is done, along with much that is altogether inferior and inefficient. The result of the Boston Herald's prize essay competition of a couple of years ago is probably still in the recollection of some of our readers. Two hundred and twenty youths of both sexes taken from the graduating classes of New England grammar schools competed for two prizes, one of six hundred dollars and one of four hundred dollars, and with what result? Let the judges who examined and pronounced upon the compositions answer:

"Two hundred and twenty compositions of all sorts and sizes, the work presumably of the best boys and girls of the schools of literary New England! What anticipations the first sight aroused! What originality, what fresh sincerity of thought and expression must lie in all this new work of new minds, unconfined by any narrow limitation of subject! Yet the end was almost absolute disappointment. The faults are greater than of mere immaturity. There is a painful constraint, a self-consciousness almost invariably present. There is an effect of insincerity, an inability or disinclination to write out real thought, that gives to the whole work a wearisome, perfunctory appearance. It may fairly be claimed that these compositions are typical. This, then, the best work that the best scholars of our schools can accomplish fails so completely of its object that the fault must be essential either to system or subject."

The general result was that, of the two hundred and twenty who competed, the vast majority simply made themselves ridiculous. What, then, may we infer of those who did not compete—the remaining members of the graduating classes, whose number must have been to that of the competitors as at least ten to one? We can only suppose that their average condition of culture would be markedly below that of the competitors. It is evident, then, that our grammar schools, indispensable as their work is, are not adequately providing for the culture even of the comparatively limited class attending them. It would indeed be making an altogether excessive demand upon them to require that they should. As to our universities, they are all doing useful and many of them excellent work, and if we looked only at the ever-extending recognition which our scholars and *savants* are receiving in the centers of learning of the Old World, we should have every reason to be satisfied with the intellectual progress of our country. More than this is wanted, however, for the object we have now in view—the spread of true culture throughout the mass of the community. As lately noticed in these columns, a hopeful attempt in this direction is being made by the university-extension system, which we can not doubt has a great and useful future before it; but, in view of the very recent articles we have published on this subject, we need not dwell specially on it to-day.

Another agency for the spread of culture is the public library, an institution existing in nearly every town of any size, and which might be turned to very good account. A generation ago the lecture system was in full activity, and was an important agent of popular education. In the present day it has been to a large extent supplanted by the newspaper and magazine press, the extraordinary development of which is one of the marvels of the age. The lecture had, however, one advantage which the magazine or newspaper does not possess, and that is that it drew people together and gave them a common interest in the subjects treated. This we consider to be a more hopeful foundation for culture, as far as it goes, than individual reading of books and papers; and here we are brought to the main point we desire to make on the present occasion which is that culture can only become general by being socially pursued. Every educated man and woman who has a living interest in the things of the intellect might and should carry on a kind of university-extension work in a quiet way among his or her own friends. Let little informal societies be formed for mutual help—let us say, in the understanding and appreciation of works of literature, or in the comprehension of social questions, or in intellectual effort of any kind—and let it be understood that the ulterior object is to promote in some small measure the great end of right and rational living, and we are persuaded that much good will be done and much social enjoyment obtained. Of course, there is a good deal of this kind of thing going on in different places, but there might be a great deal more. Too many "cultured" people think of their culture mainly, if not wholly, as a valuable personal possession, and an enviable mark of distinction from the crowd. That is a wrong and selfish view to take of it. The world is full of people who are starving for the bread of intellectual life. They may not know they are starving, but they are, all the same. Their lives are poor, empty, frivolous, and wholly unideal. Yet the sources of intellectual wealth are at their doors, and those who could open up these sources to them are among their acquaintance. Such at least is often the case, and what we are anxious to do is to rouse the possessors of culture to a sense of their responsibility in the matter. Freely they have received, why should they not freely give? Why should they not institute a propaganda of culture, and strive to redeem here and there a mind from the slavery of ignorance and commonplace?

We take this opportunity of making a long-delayed apology to a correspondent who wrote to us some four or five years ago, suggesting that a portion of each Sunday should be devoted to purposes of intellectual improvement in a social way. His letter was an interesting one, and we had ordered it for publication, when an accident destroyed both the manuscript of the letter and the writer's name and address, a circumstance which we much regretted at the time and should have referred to in these columns. We are aware of cases in which what our correspondent recommended has been done with very good results. Friends have met on Sunday evenings at one another's houses for profitable discourse, sometimes of a spontaneous and sometimes of a prearranged character. In one group with which we are acquainted, each person is supposed to read during the week as much as he or she has opportunity for and to bring to the meeting an extract of from one hundred to two hundred words taken from some favorite author. In this way the little society gathers an anthology of its own of more or less memorable passages. Other readings are given in prose or poetry, and the various topics or thoughts presented are freely discussed. In this way a common proprietorship is created in ideas which would else have remained isolated in particular minds, and it is needless to say that much correction of individual errors is at the same time made possible.

Now, what is wanted for the popularization of culture is a great extension of work, if work it can be called where so much pleasure is involved, of precisely this kind. Where university-extension classes are established, small social gatherings such as we have described would carry on their work admirably, and, where they are not established, would to some extent take their place. The signs are abundant that our people need more culture, and if those who possess culture were only animated with a little of the missionary spirit which very uncultivated people sometimes possess, they might turn their gifts and accomplishments to much better purpose than, speaking generally, they now do. What is wanted to vivify culture is a social aim—an aim of social usefulness: give it that, and it will become a power for the regeneration of the world.

An Index to Volumes I to XL of The Popular Science Monthly is well advanced in preparation, and will be published probably in the course of the coming summer. In the new Index the contents of the whole forty volumes will be entered both by author and by subject in one alphabetical list. It will possess all the best features of the most recent indexes, and will be a thoroughly practical guide to the store of information which the volumes of the magazine contain. The compiler is Mr. Frederik A. Fernald, of the editorial staff of the Monthly.

LITERARY NOTICES.

New Fragments. By John Tyndall, F. R. S. New York: D. Appleton & Co. Pp. 500. Price, $2.

The contents of this volume consist of essays and addresses prepared for various occasions and embracing a considerable range of topics. Among those dealing with natural science are a review of Goethe's *Farbenlehre*, a magazine article on Atoms, Molecules, and Ether Waves, another with the title About Common Water, and a paper on the Origin, Propagation, and Prevention of Phthisis. Tyndall's well-known power of making scientific subjects luminous and fascinating is abundantly shown throughout this volume. Take this passage from About Common Water:

> The most striking example of the color of water is probably that furnished by the Blue Grotto of Capri, in the Bay of Naples. Capri is one of the islands of the bay. At the bottom of one of its sea-cliffs there is a small arch, barely sufficient to admit a boat in fine weather, and through this arch you pass into a spacious cavern, the walls and water of which shimmer forth a magical blue light. This light has caught its color from the water through which it has passed. The entrance, as just stated, is very small, so that the illumination of the cave is almost entirely due to light which has plunged to the bottom of the sea, and returned thence to the cave. Hence the exquisite azure. The white body of a diver who plunges into the water for the amusement of visitors is also strikingly affected by the colored liquid through which he moves.

The wonderful style above illustrated contributes a great part to the effectiveness of Prof. Tyndall's teachings in science. Many a student, using one of Tyndall's treatises on Heat, Light, or Electricity as a text-book, has found himself drawn on to read far beyond the limits set for the next lesson. Obviously the books that get themselves read are the ones that produce results; hence it is probably safe to say that no book has done more to spread an understanding of the nature and behavior of one of the great forces of Nature than his Heat as a Mode of Motion.

Tyndall is still more fascinating and becomes even inspiring when he discourses of his favorite recreation, climbing the Alps. There are two essays dealing with Alpine experiences in this collection, and many of the phenomena of glaciers, snow-fields, and mountain mists are introduced into the scientific papers. The following is a description of the sort with which his Alpine chapters abound:

> At half past one o'clock on the morning of the 11th we started from the Wengern Alp. No trace of cloud was visible in the heavens, which were sown broadcast with stars. Those low down twinkled with extraordinary vivacity, many of them flashing, in quick succession, lights of different colors. . . . Over the summit of the Wetterhorn the Pleiades hung like a diadem, while at intervals a solitary meteor shot across the sky. We passed along the Alp, and then over the balled snow and broken ice shot down from the end of a glacier which fronted us. Here the ascent began; we passed by turns from snow to rock and from rock to snow. The steepness for a time was moderate, the only thing requiring caution being the thin crusts of ice upon the rocks over which water had trickled the previous day. The east gradually brightened, the stars became paler and disappeared, and at length the crown of the adjacent Jungfrau rose out of the twilight into the purple of the rising sun. The bloom crept gradually downward over the snows, until the whole mountain world partook of the color. It is not in the night nor in the day—it is not in any statical condition of the atmosphere—that the mountains look most sublime. It is during the few minutes of transition from twilight to full day through the splendors of the dawn.

Among the New Fragments are several biographical sketches, and these are fully as vivid as the essays already mentioned. The power of expression that can so greatly enliven inanimate objects is naturally no less potent in dealing with subjects that have lived. It is well for science that Tyndall's bent was turned so strongly toward scientific matters, for otherwise biography would long since have monopolized him. In reading his sketch of Count Rumford one is made to feel that the investigator of a century ago was also a *man*, and, moreover, what manner of man he was. The same applies to the account of Thomas Young; and when our author speaks of one whom he has known in the flesh, as in his Personal Recollections of Thomas Carlyle, and his address on unveiling the statue of Carlyle, the image of his subject stands out with marvelous distinctness.

Among the miscellaneous papers in this

volume should be mentioned an address on the Sabbath, in which a strict and dismal mode of observing the day is deprecated; and an address delivered at the Birkbeck Institution, which tells much of Tyndall's own student-life. Persons who have read the Fragments of Science by Tyndall will find the present volume no less interesting.

A Treatise on the Ligation of the Great Arteries in Continuity, with Observations on the Nature, Progress, and Treatment of Aneurism. By Charles A. Ballance, F. R. C. S., and Walter Edmunds, F. R. C. S. London and New York: Macmillian & Co. Pp. 568. Price, $10.

This elegant volume embodies the results of extended researches and of many experiments upon the lower animals undertaken with the view of lessening the liability to hæmorrhage after the ligation of an artery. After two brief introductory chapters the nature of arteries and the processes of physiological occlusion and pathological obliteration are described. Then the conduct and fate of the corpuscles, the clot, the coats, and the ligature are successively discussed. The phenomena of suppuration and hæmorrhage are next examined, and a chapter on the conduct and fate of the aneurism follows. Taking up the surgery of the arteries in detail, the authors give the views and practice of the earlier and later surgeons, and discuss the choice of the operation, the ligature, the knot, and the force. A concluding chapter treats of the conduct of the operation and the fate of the patient. The work is printed in large type, with wide margins, and is illustrated with ten plates, including a frontispiece portrait of Scarpa, and 232 figures.

The Genesis of Genesis. A Study of the Documentary Sources of the First Book of Moses, in Accordance with the Results of Critical Science, illustrating the Presence of Bibles within the Bible. By Benjamin Wisner Bacon. Hartford: The Student Publishing Company. Pp. 352. Price, $2.50.

In preparing this book, the author has assumed that the reading public are entitled to judge for themselves concerning the value of what is called the higher criticism. For this end they require, not controversial argument, but explanation; and he does not consider it necessary that the presentation of the case should be made from the point of view of hostility to the new theory, or even from one of indifference. An introduction by Prof. George F. Moore, of Andover Theological Seminary, gives the history of the higher criticism, or of questions of the authorship of Genesis from the time it was started by Aben Ezra, in the twelfth century. The introductory part of the work proper contains chapters on Higher Criticism and the Science of Documentary Analysis, The Science of Biblical Criticism, and The Documentary Theory of To-day. In Part II is shown the text of Genesis according to the Revised Version, in varieties of type to exhibit the constituent sources and method of their compilation according to the general consensus of critical analysis, with notes explanatory of the phenomena of reduction. Part III presents the separate documents designated as J, E, and P, conjecturally restored, with revised translation according to emended text and conjectural readings of good authority. In the appendix are given "the great flood interpolation and connected passages, placed in juxtaposition with a translation of their cuneiform parallels."

A Text-Book of Bacteriology. By Carl Fraenkel, M. D., Professor of Hygiene, University of Königsberg. Translated and edited from the third German edition by J. H. Linsley, M. D., Professor of Pathology and Bacteriology in the University of Vermont. New York: William Wood & Co. Pp. 380. Price, $3.75.

Systematic study of the bacteria is included at present not only in the curriculum of medical schools, but also forms part of a biological course in many of our universities. Its interpretation of the causes of disease has led to a sense of its value, and the methods of German and French investigators are followed with increasing eagerness by students. A considerable number of volumes consisting of translations and original lectures upon the subject is already accessible in English, but no one of these is perhaps an adequate text-book. Dr. Linsley has therefore translated and adapted to use Fraenkel's *Grundriss der Bakterienkunde*, a manual whose worth is attested by its rendering into six different languages.

In this work little space is allowed for argument. The bacteria are classified at once as "the lowest members of the vegetable kingdom, closely related to the algæ." Separate species are found among them, differentiated by growth and shape. According to their forms they are divided into the globular bacteria or micrococci, the rod-shaped or bacilli, and the screw-like or spirilla. Their structure, multiplication, conditions necessary for growth, and resultant phenomena are next considered.

The benefits of oil immersion and of the Abbe illuminating apparatus are unfolded in Methods of Investigation, and the learner is instructed in the handling of the microscope and making of stains. Even the common errors of beginners are outlined for the student, and he is warned not to mistake the broken nuclei of white blood-cells for bacilli, when the glasses have been too hastily pulled apart, or to fancy he has discovered a colony of micrococci when some plasma-cells betray idiosyncrasies in absorbing aniline colors.

Full directions are given for the various processes involved in successful breeding, sterilization, and the preparation of liquid and solid food media.

The noxious character of pathogenic bacteria is shown to consist not in the mechanical effect of their presence, nor in the hospitality they may exact from their host, but in the alkaloidal poisons they generate. Fraenkel inclines to the belief that the organism resists through a germ-killing power which resides in the living albumin of the serum, and that victory over invading bacilli is a chemical one and not the pitched battle of the *phagocytes*. Some of the interesting experiments of Metschnikoff in defense of his theory are not quoted, but his views are fairly represented. The author admits as pathogenic bacteria only those which comply with three conditions: first, that they are invariably present with the morbid affection; second, that they can be cultivated outside of the organism; thirdly, when the same pathological effects follow inoculation of the artificial culture. Petri's method of finding the number of bacteria in a given quantity of air is preferred. Only three to five germs in a litre is the average amount computed for an ordinary dwelling. Bacteriological examination of the soil is complicated and of little use, but that of water is extremely important, although the determination of species is difficult. "Water may be harmless and contain five thousand germs of the hay bacillus to the cubic centimetre, but ten germs among which are two cholera vibrios and two typhoid bacilli render it dangerous."

The principal mold and yeast fungi are briefly noticed in the appendix. The book is indexed, but lacks illustrations. Minute descriptions atone for this; however, the student is expected to illustrate for himself in the best way—by observation of the living object.

The Electric Railway in Theory and Practice. By Oscar T. Crosby and Louis Bell, Ph. D. New York: W. J. Johnston Co., Limited. Pp. 400. Illustrated. Price, $2.50.

Although electric traction in the United States only dates from 1884, its development has been so rapid that for public transit in towns and cities it would seem that the days of the horse are numbered. Of electric locomotion as a science and art this book is a clear and thorough presentation. Beginning with an outline of electrical theory, the authors proceed at once to practical details. The considerations which should determine the placing of a station are first discussed, as also the economical adaptation of plant to a specific volume of traffic and frequency of service. Steam-engines and water-wheels of the best models are described and their merits carefully discriminated. Motors and car equipment are then canvassed, and the various approved methods of building lines and track are illustrated. The trolley, underground conduit, and storage-battery systems are next compared, with a complete array of evidence *pro* and *con*.

Mr. Crosby, one of the authors, has conducted the only series of experiments ever undertaken with intent to double railroad speeds. In one of the most interesting chapters in the book he gives all the facts in the case, with cautiously deduced estimates. His conclusion is, that with electric motors of the highest efficiency, there is an advantage over the locomotive at all speeds. This advantage is fifteen per cent at twenty miles an hour, and steadily increases as the rate is quickened. Where motors are liable to a loss of one fifth in efficiency they are on an equality with locomotives at sixty miles an hour; below that speed the locomotive is to be preferred; beyond it, the motor is the cheaper servant.

While this work shows evidence on every page of the scientific mastery of its subject, the authors are plainly men desirous of meeting the practical difficulties which the operation of electric railways presents every day. They are also fully aware that the investor is less interested in the analysis of electrical machinery than in the simple question, Will it pay? Commercial considerations receive full and sensible treatment. Others than superintendents and investors can read this work with profit. It is as good an example as American literature contains of scientific principles applied to the solution of practical problems—problems, too, as important in their social as in their commercial bearings. Progress in electric traction means the relief of congested cities, the expansion of wholesome suburbs, on a scale impossible to the steam locomotive. In long-distance service it stands for an advance second only to that due to George Stephenson.

Scientific Correspondence of Joseph Priestley. Edited, with Copious Notes, by Henry Carrington Bolton. New York: privately printed. Pp. 240. Price, $2.50. E. F. Brown, 180 Warren Street, Brooklyn, Agent.

The "Father of Pneumatic Chemistry" expected to be remembered chiefly for the theological views which he put forth, having been in early life a Unitarian minister, and a writer on theological subjects throughout his career. Hence his modest autobiography, which was expanded into two volumes, with the addition of several hundred letters, by his son and J. T. Rutt, contains almost nothing about his scientific investigations. To supply the lack of material relating to his work in the latter field, Dr. Bolton has collected ninety-seven letters, nearly all written by Priestley, his correspondents being Josiah Wedgwood, Captain James Keir, Sir Joseph Banks, and others in England, and Dr. Benjamin Rush and others in America after he came to this country. They contain many interesting details concerning the progress of his researches on the gases, several of the most important of which were discovered by him. The letters are supplemented by many biographical, bibliographical, and explanatory notes by the editor, and the volume contains a portrait of Priestley and one of Josiah Wedgwood. There is also a synopsis of correspondence of Dr. Priestley, consisting chiefly of letters from him to his brother-in-law, Mr. Wilkinson, from 1790 to 1802. An appendix contains a descriptive list of the likenesses of Joseph Priestley in oil, ink, marble, and metal, embracing ninety-three items; an account of the Lunar Society, in Birmingham, founded by Matthew Boulton, Erasmus Darwin, and others, and of which Priestley was a member; and an inventory of Dr. Priestley's laboratory, which was sacked by rioters in 1791.

Diphtheria: its Natural History and Prevention. By R. Thorne Thorne, F. R. S. London and New York: Macmillan & Co. Pp. 266. Price, $2.

Statistics show that the death-rate from diphtheria in England and Wales has been increasing during the last twenty years, and more rapidly in the cities than in the country. This disease thus presents a contrast to the majority of zymotic diseases, the death-rate from which has been lessened as physicians have gained more knowledge of their nature and as sanitary conditions have been improved. In view of its fatal and little understood character, the author has undertaken to collect what is known in regard to diphtheria. It appears that the broad geological features of a district have no influence on the development or diffusion of the disease. A chart prepared by Dr. G. B. Longstaff shows that the death-rate has been high in some counties and low in others on the same geological formation. Yet the author is convinced that a surface soil which retains wetness and organic refuse, together with an aspect exposed to cold wet winds, tend to the fatality of diphtheria. He further discusses the general nature of the disease, its relation to scarlet fever and to croup, the influence of schools in spreading the infection, and milk as a vehicle in which it may be carried. The measures of prevention which are suggested by his study of the subject are stated in detail, and his general conclusions as to the natural history of diphtheria are also given. The volume contains three folded plates illustrating the relation of diphtheria to geology and topography.

Direct Legislation by the Citizenship through the Initiative and Referendum. By J. W. Sullivan. New York: Twentieth Century Co. Pp. 120. Price, cloth, 75 cents; paper, 25 cents.

When an American learns that Switzerland is far in the lead of her sister republics in the practice of democratic government, many questions arise in his mind. This little book is designed to answer them. Mr. Sullivan concisely recounts the progress of Switzerland in direct legislation during the past sixty years, and shows the remarkable influence of this legislation on the institutions of the country. The statistics he cites prove a very notable diffusion of prosperity. He next shows that to a considerable length direct legislation is practiced in the United States in township, county, and State governments, as well as in the national trades and labor organizations. In his concluding chapter Mr. Sullivan, although a strenuous individualist, argues that in direct legislation lies an open way to a peaceful political and economic revolution. To the Swiss referendum it is often objected that many legislative questions are above the ordinary voter's comprehension, and demand the specially trained mind of his representative. But would not this check of comprehensibility keep law-making within legitimate bounds, and abolish the antagonism which so often exists between the interests of the people and those of their legislators?

Elementary Text-Book of Zoölogy. By Dr. C. Claus. Translated and edited by Prof. Adam Sedgwick. Second edition. London and New York: Macmillan & Co. Two vols. Price, $8.

Among the German scientific text-books that have won high favor among American instructors is this work on zoölogy by Dr. Claus. It is in two volumes, the first comprising the General Part and the first Special Part—Protozoa to Insecta; the second volume containing the other Special Part—Mollusca to Man. In the General Part a bird's-eye view of the organization and development of animals in general is given, and this is followed by a brief historical review of the science of zoölogy, an explanation of the classification of the present day, and a statement of the evidence in favor of Darwin's theory of descent. In the special chapters which constitute the rest of the work, types of the several families are described with considerable detail. The text is illustrated with seven hundred and six woodcuts in Volume I and two hundred and five in the smaller Volume II.

Besides the list of towns and cities having water-works, and accounts of their works, *The Manual of American Water-Works* contains summaries and statistical information of great value to persons who are concerned in this subject. From it we learn that there were 2,037 water-works in operation on July 1, 1891, supplying 2,187 cities, towns, and villages; while in Canada there are 95 works, supplying 102 towns. Tables are given showing the distribution of this supply in the several States and provinces and groups of the same; towns having more than one plant; summaries of populations supplied; miles of mains, etc., also by States and groups. The last tables show that 22,814,061, or about 36 per cent of the inhabitants of the United States, live in towns having public water-works, and that only a few towns having 8,000 or more inhabitants are without works. The reported cost of 1,802 of the water-works in the United States and Canada aggregates $504,035,492. Other tables represent growth by number of works and populations supplied; dates of construction by groups of States and half decades; like summaries of works completed or under construction since 1880, and of works projected; information respecting the management of public water-works and tenure of office of governing bodies; consumption of water and use of metres; ownership, whether by the public or by private companies; franchises of water-works companies; and other facts of related character. The main part of the book comprises the list of water-works, given by States according to their geographical arrangement and by towns alphabetically, and comprising the items of history, source of supply, mechanism, financial condition, and managing boards.

A Preliminary Report on the Coal Deposits of Missouri has been prepared by the State Geologist, *Arthur Winslow*, in order that something may be at hand to meet immediate calls upon the survey for information concerning the coal deposits of the State. It embodies part of the results of such observations in the coal-fields as the author was able personally to make in 1890 and 1891. While the descriptions of the details of sections, the correlation of the different coal-beds, the definition of the individual areas of the coal-beds, and the adaptabilities of the coals for steaming purposes are reserved for future reports or only briefly touched upon, and the report is not exhaustive or elaborate, it is comprehensive. It aims to present, in general terms, an outline of the conditions of occurrence and distribution of coal in the entire State, and contains a descriptive reference to every county in which coal is known to exist. Special effort has been made to obtain and include all information and results particularly relating to coal that were not obtainable at the time the earlier surveys of the State were in operation. Of especial value are the records of the various deep shafts and drill-holes which are included in the report. The well-executed sectional diagrams of the several coal mines described contribute much to the satisfactory impression made by the report.

The principles of sound physical development, graceful carriage, and easy posture are taught in the little manual on *Delsartean Physical Culture*, which has been prepared for seminaries, classes, private teachers, and individuals by *Carrica Le Favre*, and is published by the Fowler & Wells Company. The rules and exercises prescribed are simple and plain, and such as, with patience and attention, are easily carried out.

In *The Modern Cook-book* (Mast, Crowell & Kirkpatrick, Springfield, Ohio) an acceptable addition has been made to this class of books by Mrs. *T. J. Kirkpatrick*. The recipes are numerous, various, and simple, and are classified. The author has found that all the cook-books that have come under her observation lack something of completeness, and has endeavored to fill the want so far as she could by presenting a book containing a moderate number of recipes, all practical and working. The recipes are tabulated wherever it is possible; the bills of fare are not for state occasions, but for plain, every-day cooking; and the directions are full, minute, and systematic.

In the series of catalogues compiled by *W. M. Griswold* (Cambridge, Mass.), we notice the *Descriptive List of Romantic N.vels*, the object of which is to direct readers, who would enjoy books of this kind, to a number of novels, easily obtainable, but which, in many cases, have been forgotten within a year or two after publication. The purpose has been to include only such works as are well written, interesting, and free from sensationalism, sentimentality, and pretense. The list is alphabetical, by titles, and is supplemented by an alphabetical index of authors.

A pamphlet on *Roads Improvement*, published by the *League of American Wheelmen*, contains three papers enforcing the importance of good roads, and showing by citations of what has been accomplished abroad what can be done toward making them. The papers are: The Common Roads of Europe and America, by Isaac B. Potter; Highways and National Prosperity, by Edward P. North; and The Importance of Good Wagon-roads, by Prof. Lewis M. Haupt. The arguments of these papers are re-enforced in the most striking style by contrasted photographic views of scenes on the common roads of the United States, even near large cities, and the finished highways, even in rural districts, of England, Ireland, and Brittany.

A summary of *Recent Advances in Electricity, Electric Lighting, Magnetism, Telegraphy, Telephony*, etc., edited by *Henry Greer* and published at the New York Agent College of Electrical Engineering, contains articles on The Storage of Electricity; The Brush Storage System; other notices of storage batteries, accumulators, etc.; Telegraphing from a Moving Railway Train (Phelps's system); Navigable Trains of Air-ships (electricity being the motive power); and Edison's paper on his Pyromagnetic Dynamo, or machine for producing electricity directly from fuel, Price, $1.

A second series of *Papers in Penology*, compiled by the *Editor of the Summary*, and published at the New York State Reformatory at Elmira, contains papers on The Prisons of Great Britain, by Jay S. Butler; Modern Prison Science, by Prof. Charles A. Collin; The Philosophy of Crime, by William T. Harris; Criminal Anthropology, by Hamilton D. Wey; New York's Prison Laws, by Eugene Smith; Prison Labor Systems; and The Elmira Reformatory of To-day. The mechanical work upon the publication, including the etching of the cover, has been done by inmates of the reformatory.

The *Report on the Coal Measures of the Plateau Region of Alabama*, made to the State Geologist by Mr. Henry McCalley, treats of all the coal measures of the plateau region, except those that were included in the Report of the Warrior Coal-field, published in 1886; and also speaks of the coal measures of St. Clair and Shelby Counties, whose measures are principally of plateau strata, and have not been considered as a whole in any previous report. A general description of the plateau region is given in the introduction; and notes and a short report by General A. M. Gibson are added on the Coal Measures of Blount and Berry Mountains. Some parts of this plateau region are likely to prove important coal areas. A map of the coal-fields and two geological sections are inserted in the volume.

The *Report of S. P. Langley*, Secretary of the Smithsonian Institution, for the year ending with June, 1891, includes the work placed under its charge by Congress in the National Museum, the Bureau of Ethnology, the International Exchanges, the National Zoölogical Park, and the Astro-Physical Observatory. By saving in other quarters, the Institution has been able to revert in some measure to an early practice of offering aid in original research. It has made grants for work on a universal standard of measure, founded on the wave-length of light; for determinations of the densities of oxygen and hydrogen; for photographs of the moon; and for investigations upon chemical compounds. In the Bureau of Ethnology efforts are made to secure records of Indian languages before they pass away.

A *Catalogue of Prehistoric Works East of the Rocky Mountains*, preliminary to a complete and thorough catalogue to be made as soon as the work can be accomplished, has been prepared by Dr. *Cyrus Thomas*, and is published by the Bureau of Ethnology. It contains lists of all the works within the territory described, of which mention has been found in any books or reports, as accurately located and described as the accounts given in the original or other best authorities will permit. The notices are perhaps often indefinite and frequently incorrect, on account of defects in these original authorities; but it is hoped that their appearance in the present shape will lead to more careful examination and to the preparation of the complete catalogue which it is hoped to make. The list is accompanied by a map of the distribution of mounds in the United States, and by State maps showing the location of prehistoric works.

The *Report of the Botanical Department of the New Jersey Agricultural Experiment Station*, by *Byron D. Halsted*, botanist, is one of the most valuable publications that have yet issued from the experiment stations. A considerable part of the report is devoted to the record of the study of fungus forms injurious to crops, made during a season in which fungoid growths were very prevalent—including cranberry scald, sweet-potato rots, etc. The causes of the failure of the peach crop in 1890 are investigated. Considerable space is devoted to the account of the work done on the weeds of the State, including a listing of them with botanical and local names, estimates by different observers of their relative degrees of noxiousness, and twenty-four page plates of the worst weeds.

In a Doctor's Thesis on *The Right of the State to Be*, an attempt is made by Prof. *F. M. Taylor* to determine the ultimate human prerogative on which government rests. The author assumes that most previous efforts to answer the question presented in the title have referred to incidentals and have not been sufficiently directed to the main question. He seeks the solution of this. First, he maintains the reality of the problem and defines its nature; next he reviews previous theories, and points out their defects; and, finally, he explains and defends his own theory. This theory bases the right on the prerogative which is assumed to belong to every person as such to rule, or to interfere coercively with the liberty of other persons in order to maintain his version of the jural ideal. Government then becomes the collective exercise by the community of their individual prerogatives combined into a single authority.

The third edition of Prof. *Simon Henry Gage's* manual of *The Microscope and Histology* has been entirely rewritten, enlarged, and more fully illustrated; and, while elementary matters have received fuller treatment than in previous editions, special effort has been made in this to give more adequate accounts of certain apparatus which are coming to be used more and more in the higher fields of investigation in pure science and in practical medicine. In order to encourage students to do their own work, exercises illustrating the principles of the microscope and the methods of employing it have been made an integral part of the treatise. To this branch of the subject the volume now before us, constituting Part I of the work—The Microscope and Microscopical Methods—is largely devoted. (Printed and for sale by Andrus & Church, Ithaca, N. Y. Price $1.)

In the report of Mr. *Theodore B. Comstock*, *On the Geology and Mineral Resources of the Central Mineral Region of Texas* for 1890, about a thousand miles are added to the area given in the previous report as that of the pre-carboniferous rocks comprising the regions described, Silurian and Cambrian strata having been discovered in fields that were supposed to be covered by the Cretaceous. In order to give special prominence to economical results, the outline of the stratigraphy introduced is prepared with the primary object of affording a kind of key to those whose practical needs preclude the task of selecting from the mass of technical description the particular details which apply to individual cases. For the benefit of the same class of persons a most useful series of directions are given for finding in the report at once the information concerning the reader's particular locality, by the aid of which he may judge what method of development may be most economical and profitable.

Part II of the fourth volume of *The Journal of the College of Science*, Imperial University, Japan, contains seven papers, five of which are by Japanese authors, while one is a joint production. They are On some Fossil Plants from the Coal-bearing Series of Nagato, and On some Cretaceous Fossils from Shikoku, by Matajiro Yokoyama; Comparison of Earthquake Measurements made in a Pit and on the Surface Ground, by Prof. S. Sekiya; Laboratory Notes, by Prof. C. G. Knott; Diffraction Phenomena produced by an Aperture on a Curved Surface, and Effect of Magnetization on the Permanent Twist of Nickel Wire, by H. Nagaoka; and On Certain Thermo-electric Effects of Stress in Iron, by Prof. Knott and S. Kimura.

Edward Flügel's study of *Thomas Carlyle's Moral and Religious Development* is published in a translation by *Jessica Gilbert Tyler*, by M. L. Holbrook & Co. The main object of the book is defined by the author to be to consider Carlyle as a moral force. Before turning attention, however, to his moral and religious views, a brief consideration is given to the history of his inner life, especially with reference to its moral and religious side. In this sense chapters are given among the others to Carlyle's Belief, his Relation to Christianity, his Position with Reference to Science, and especially to Philosophy, to Poetry, and Art, his Attitude toward History, and his Ethics.

A series of articles upon the trees of Salem, Mass., and its neighborhood, prepared by Mr. *John Robinson*, in 1890 and 1891, for one of the newspapers of that city, have been published by the Essex Institution in book form under the title of *Our Trees*. They give a popular account of the trees in the streets and gardens of the city and of the native trees of Essex County, with the location of the trees and historical and botanical notes. They were written wholly with an eye to popular entertainment and instruction, but prepared with considerable care and a regard to scientific accuracy. In them we have accounts of the character of the magnolias, tulip tree, lindens, tamarix, sumachs, horse-chestnuts, maples, locusts, apples, pears, cherries, dogwoods, tupelo, witch-hazel, ashes, catalpa, sassafras, elms, box-tree, mulberries, buttonwood, walnuts, hickories, birches, hornbeams, chestnut, beech, oaks, willows, poplars, pines, spruces, fir, hemlock, larches, cedar, gingko, and yew. One hundred and fifteen species grow in the region, of which fifty-six are natives of Essex County.

A collection of papers on the *Quaternary Geology of the Hudson River Valley* is intended as a preliminary contribution by Mr.

Frederick J. H. Merrill to that subject. The papers relate to the historic and economic geology of the field. The first paper, on the Post-Glacial History of the Valley, is the result of several seasons' study by the author. The papers on Brick Clays and the Manufacture of Brick were prepared under the author's direction by Mr. Heinrich Ries, after a detailed investigation of the region between Croton and Albany.

A study of the Evolution of the Myth of Satan is presented by Mr. *William Henry Hudson* in a paper which was originally delivered as a Sunday evening lecture, on *The Satan of Theology and how we came by him.* The author finds that the Satan of the Book of Job bears no resemblance to the spirit of evil in our modern theology, while the tempter, or serpent in the garden of Eden, was not identified with Satan till Persian influence had begun to operate. The real origin of the theological devil is then sought in the dualistic conception of the Zoroastrian religion, which was transplanted into Judaism and has been built upon till it has grown into the present accepted figure.

Of two *Addresses on Anatomy*, reprinted by the author, Dr. *Harrison Allen*, of the University of Pennsylvania, for more convenience in reading, the first, On Comparative Anatomy as a Part of the Medical Curriculum, was delivered before the American Association for the Advancement of Science, at its Boston meeting, in 1880; and the second, On the Teaching of Anatomy to Advanced Students, before the Association of American Anatomists, at Washington, in 1891. The second address outlines a plan for a thorough fundamental course of instruction in the science, representing the idea which the author has long cherished for having medical biologists as systematically trained as those who elect the more general field of natural history.

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POPULAR MISCELLANY.

Origin of Greenland Vegetation.—Some interesting conclusions are drawn by Mr. Clement Reid from a comparison of the views of Prof. Warming and Prof. Nathorst concerning the origin of the flora of Greenland. Prof. Warming fixes the boundary between the European and American provinces of the arctic flora as in Denmark Strait, and not in Davis Strait, as botanists have generally placed it. The flowering plants of Greenland include three hundred and eighty-six species, none of which are confined to that country. Of these, excluding the circumpolar forms, Prof. Warming finds in the list thirty-six characteristic Western against forty-two Eastern species; but suggests that as the flora of arctic America is better known, the balance will probably be in favor of the Western forms. He, however, includes among the Eastern plants only those now living in Europe, while he classes the Asiatic-American species as Western. Prof. Nathorst reviews these conclusions on the basis of a map of the local distribution of Eastern and Western forms in Greenland. He thus finds that the coast nearest to Iceland contains European forms alone, the southern coast contains European forms in a majority, and that part of the west coast nearest to America yields principally Western species; but taking Greenland as a whole the flora is more European than American. He also finds that the American element of the flora of Greenland is not entirely cut off by the Denmark Strait, but extends eastward as far as Iceland. Prof. Warming believes that the nucleus of the present flora of Greenland represents part of the original flora which was able to live through the Glacial epoch on the non-glaciated areas; but Prof. Nathorst shows that the few non-glaciated mountain-tops must have been far too high for any phanerogams to exist on them, and all the lowlands were then covered with ice and snow. Both the Eastern and Western elements of the present flora of Greenland must, therefore, be supposed to have entered the country in post-glacial times. The tables of distribution show at what points a large number of the plants entered; they came from the nearest land, whether European or American. The ice-foot, which collects in winter beneath the sea-cliffs, is placed in the best possible position to receive any seeds or masses of soil which may fall during the winter. This shore-ice is drifted away in the spring, and may easily discharge its burden on some far-distant shore uninjured, and with the seeds just ready to germinate. Winds, migrating birds, and migrating mammals, would all help to transport seeds across the straits.

Early Title-pages.—In the earliest printed books and in manuscripts any information on the workmanship of the book was written at the end, in what is called the colophon. It was not till 1470, according to Mr. A. W. Pollard, in his History of the Title-page, that a title-page was introduced, and in England not till shortly before 1490, when W. de Machline issued one to his little book on the pestilence. Caxton never used them, but Wynkyn de Worde employed them in nearly all his books. At the beginning of the next century are found the most interesting, if not the most artistic, titles. Popular demand then required a large woodcut on the front page, whatever was the subject of the book. Even school-books were adorned with representations of masters and scholars, the most striking object in the cut being a formidably large birch. The nature of most of the religious books required a frontispiece containing devils. The little books of poetry and romance which issued from the press by hundreds contain the best specimens of this kind of art. Looking at these title-pages from the artistic side alone, England makes but a poor show against France and Italy. Nothing could be finer than the title-pages of the Parisian books in the early part of the sixteenth century. After this time the decadence began, and the printers finally became "dreadfully utilitarian and unromantic."

The Primary Color of Leaves.—Having concluded, as has already been mentioned in the Monthly, that the primary color of flowers is white, from which the characteristic hne is developed as a secondary color, E. Williams Hervey asks, in Garden and Forest, What is the primary color of the green parts of the plant? Leaves do not generally have a different color at the base from the usual one, as has been shown to be the case with flowers; and they rarely, except in the purplish leaves of vigorous saplings and a few cultivated plants, have any other color than green. But the leaves of some cultivated plants are spotted, striped, or bordered with white; bleached celery stalks are white, and the inner leaves of cabbages are white. From these instances "we get pretty strong hints that green is derived from white. There remains one more clew. Every botanist knows that the seed contains a miniature and rudimentary plant; that generally the most prominent parts of the seed are the cotyledons or seed-leaves, and these are, of course, the first leaves of every species of plants. Now, if we ascertain the color of these seed-leaves, we find the original color of all leaves. This color is uniformly white; . . . of course, we do not refer to the colored integument of the seed, which, as in the case of garden leaves, may be white, red, yellow, blue, black, or of mixed colors, but to the kernel, or meat. There are a very few instances only where the green color has impressed, somewhat, that characteristic upon the seed, as in peas, nasturtiums, and maples, which present a pale-green color in the pod or shell. In some instances these cotyledons appear above the surface of the ground, changing from white to green; while in others they remain below." We learn from this study of color, therefore, the author adds, "that white is the primary color of root, stem, and flower, and the foundation of all color."

A New Electric Light.—A vast improvement in artificial illumination is promised in the light which Mr. Tesla, "the able lieutenant of Mr. Edison," has been exhibiting in London. An experiment performed by him before the Royal Institution consists, according to the Spectator's account, in joining two sheets of tin-foil, one over the lecturer's head, the other on the table, to the poles of the generator. The space between these two sheets immediately became electrified, and a long vacuum-tube waved about in it, without attachment to any conductor, glowed in the darkness like a flaming sword. The experiment was intended to illustrate the possibility of rendering an entire room so electric, by plates in the ceiling or under the floor, that vacuum-bulbs placed anywhere within it would yield a light. Thus we shall be able to fill our rooms with the potentiality of light, and then, by the simple introduction of vacuum-tubes, to obtain any quantity of it. Those who want a daylight without heat will be able to run a vacuum-tube round the whole length of the cornice, and so obtain a diffused illumination of almost any brilliancy. The fact is noticed, in connection with the experiments, that the lecturer stood in an "electrostatic field" capable of illuminating a lamp without wires, and felt nothing. More, he held a vacuum-tube in one hand and touched a "terminal" with the other, a process which made him "the channel for a current of something like fifty thousand volts," and yet did not receive any injury.

Venerable Trees.—A very interesting work is in course of publication by M. Gadeau de Kerville, on the ancient trees of Normandy. The most remarkable trees so far described are the two yews of La Haye de Routot, in the department of the Eure. They are respectively $9\frac{1}{2}$ and $8\frac{1}{4}$ metres in circumference at the base of the trunk, and $17\frac{1}{2}$ and $14\frac{1}{2}$ metres high. Their ages are estimated by the author to be not less than fifteen hundred years. A chapel has been constructed in the hollow trunk of one of these yews, three metres high and two metres deep. Before it was transformed into a chapel the hollow would hold forty persons, and eight musicians have played in it in concert. The beech of Montigny, estimated by the author to be between six hundred and nine hundred years old, is 18 metres high and 8·20 metres in circumference at the base. There are oaks from two hundred to nine hundred years old, one of which is nearly forty metres high.

Curious Effects of an Earthquake.—Some striking features are described by Prof. John Milne as marking the recent destructive earthquake in Japan, by which nearly 8,000 persons were killed and at least 41,000 houses were leveled. The movements of the wave were horizontal, and a defect of the seismograph was noticed in its failure to record anything of them except the "dip." In many places so-called "foreign" buildings of brick and stone fell in heaps of ruin between Japanese buildings yet standing. "Cotton-mills have fallen in, while their tall brick chimneys have been whipped off at about half their height. Huge cast-iron columns, which, unlike chimneys, are uniform in section, acting as piers for railway bridges, have been cut in two near their base. In some instances these have been snapped into pieces much as we might snap a carrot, and the fragments thrown down upon the shingle beaches of the rivers. The greatest efforts appear to have been exerted where masonry piers carrying two-hundred-foot girders over lengths of eighteen hundred feet have been cut in two, and then danced and twisted over their solid foundations to a considerable distance from their true positions. These piers have a sectional area of twenty-six by ten feet, and are from thirty to fifty feet in height. Embankments have been spread outward or shot away, brick arches have fallen between their abutments, while the railway line itself has been bent into a series of snakelike folds and hummocked into waves. . . . Here and there a temple has escaped destruction, partly perhaps on account of the quality of materials employed in its construction, but also in consequence of the multiplicity of joints which come between the roof and the supporting columns. At these joints there has been a basket-like yielding, and the interstice of the roof has not, therefore, acted with its whole force in tending to rupture its supports."

Meteorology Five Centuries ago.—What is probably the oldest journal of the weather in existence has recently been recovered, printed in photographic transcript, and translated. It was kept by the Rev. William Merle, rector of Driby, Lincolnshire, England, from 1337 to 1344, or during seven years of the earlier part of the reign of Edward III. The author was evidently a keen observer, and recorded his facts succinctly and intelligently, so as to give a graphic, even picturesque description of the weather by the week or month; and a reference in one of his notes to a feature of the season of 1331 shows that he had been watching the changes of the seasons for a longer time than was covered by his journal. Some of the entries are suggestive of the conditions and ways of thinking of the times. The frequent mention of weather conditions and phenomena in other parts of the kingdom indicates that there were other observers in England who corresponded with Merle. A comet was seen in the second week of September, 1343, appearing about sunset. Our author called it "*ardens draco*," or burning dragon, but did not seem terrified by it. He merely remarked that it was a sign of dry weather. In the same year, on the 28th of March, is entered a notice of an earthquake so violent that the stones of the chimneys in certain parts of Lindsey were thrown down. The motion lasted while one might say the angelic salutation, which was about half as long then as it is now. The mention of stones falling in the stone chimneys — "*lapides in caminis lapideis*" — is interesting, as it proves the fallacy of the belief that chimneys are a late invention, and that the English of those times were so barbarous that the smoke was got rid of by means of a hole in the roof. The recovery of the journal is due to a mention of it by Dr. Plot, of the Royal Society, in 1685, as being in the Bodleian Library. It was looked for and found.

Drops of Fog.—Advantage was taken by Mr. John Aitken, during a visit to the Righi, of the opportunities that were afforded there for investigating the water particles in clouds. With an instrument the author has invented those particles were distinctly seen showering down, and the number falling on the micrometer was easily counted. The number was observed to vary greatly from time to time. The greatest rate actually counted was sixty drops per square millimetre in thirty seconds, but for a few seconds the rate was much quicker. The maximum rate named gives twelve thousand drops per square centimetre per minute, or seventy-seven thousand four hundred drops per square inch per minute. The drops are so extremely small that they rapidly evaporate, more than two or three being seldom visible at the same time on one square of the micrometer. The denser the cloud the quicker was the rate of fall, and as the cloud thinned away the drops fell at longer intervals, and they diminished in size at the same time. It was frequently observed when the mountain-top was in clouds, particularly if they were not very dense overhead, that the surfaces of all exposed objects were dry—not only the stones on the ground, which might have received heat from the earth, but also wooden seats, posts, etc. —and if wetted they soon dried. And while everything was dry, the fog-counter showed that fine rain-drops were falling in immense numbers, and the air, on testing, was found to be saturated. A few observations were therefore made to explain the apparent contradiction of surfaces remaining dry while exposed to a continued shower of fine rain and surrounded by saturated air. The explanation was found to be, simply, radiant heat. A considerable amount of heat, as also of light, was found to penetrate the clouds, notwithstanding their density. This radiant heat is absorbed by all exposed surfaces and heats them, while they in turn heat the air in contact with them, and the fine drops of water are either evaporated in this hot layer of air or after they come in contact with the heated surfaces. Other observations made on Mount Pilatus pointed to the same conclusion. All large objects, such as seats, posts, etc., were dry in cloud when there was any radiation ; while small objects, such as pins, fine threads, etc., were covered with beads of water. The large surfaces being more heated by radiation than small ones, when surrounded by air, these surfaces evaporate the drops falling on them, while the small ones, being kept cool by the passing air, are unable to keep themselves free. The observations made with the fog-counter point to the conclusion that the density or thickness of a cloud depends more on the number of water particles than on the number of dust particles in it.

Mortality and Morbidity by Professions.—M. Jacques Bertillon recently communicated to the French Society of Public Medicine a table of mortality by professions, compiled from official documents of the city of Paris from 1885 to 1889. This is the first table of the kind that has been made in France. Other tables have been made in England by Mr. William Farr and by Mr. Ogle, compiled from the returns of census years, and in Switzerland by M. Kummer for the years 1879 to 1882. On a comparison of the results of these four tables, made with special reference to the relative number for each profession, and taking the general average of each country observed, the author has found that the same professions give nearly the same results in the three countries. When, however, we compare these results with the tables of morbidity or liability to disease by professions, drawn up by M. Bodio, from the observations of the Italian societies of mutual aid, we find them at times apparently contradictory. This confirms the principle that in the existing condition of things a table of morbidity is not of as much value as a table of mortality as a means of determining the sanitary condition of a population. This arises from the fact that it is a very delicate matter to distinguish a disease from a simple indisposition, as well as to distinguish an acute from a chronic disease, and the latter, again, from an infirmity.

Meteoric Iron.—Native meteoric nickel iron, according to Prof. Ledebur, of Freiberg, is too costly to be available for practical use. The market prices are about 6*d.* per gramme for ordinary qualities, and from 1*s.* 6*d.* to 2*s.* 6*d.* per gramme for the rarer qualities, and from 17*s.* to 26*s.* per gramme for iron the fall of which has been observed. Still it is not extremely rare, at least not in museums. The museum at Vienna has 1,033 kilogrammes of it, of specimens that were found in 145 different places; the collection of the University of Berlin is rich in specimens; the Natural History Museum at Paris has a considerable quantity of it; and the British Museum has 3,600 kilogrammes in a single block. The largest piece in any collection is one weighing 5,000 kilogrammes, from Bemdego, Bahia, in the museum at Rio de Janeiro. It is believed to be a fragment of a meteor of 9,000 kilogrammes which was discovered in 1784. A mass described by Humboldt was estimated to weigh from 15,000 to 20,000 kilogrammes. Evidence is adduced by Herr Otto Vogel, of Düsseldorf, to show that meteoric or nickel iron is found over most of the world, and has been worked to the most recent times; and that it was also worked and used in the middle ages and in a remote antiquity. The negroes on the Senegal River were found working it by Buchner; the Namaquas of South Africa made weapons from it; and the Indians of Islahuaca manufactured agricultural implements and other tools from it as early as 1784. Captain Ross, in 1819, found the Eskimos of Greenland using meteoric iron in making lines and other tools; and there is a knife-blade of this iron in the Natural History Museum at Vienna, where is also preserved an arrow-head of it from Madagascar. The author suggests that it may easily be assumed that the first iron that was ever wrought was cosmic iron—that is to say, an iron derived from another world. "On such foundlings," says Mehrtens, "the uncultured inhabitants of our earth may first have tried their skill out of curiosity, and perhaps by chance have discovered the properties of iron."

The Power of Assertion.—A political article in a recent number of The Spectator is prefaced by some general remarks on the power that mere assertion exerts. The majority of persons, whether of high or low degree, have little inclination or opportunity for verifying statements. Hence an assertion that is made strongly and circumstantially enough passes with these persons for solid fact. The task of exposing and rebutting a misstatement is almost a waste of labor. In political affairs, especially, there is very little to lose and a great deal to gain in making reckless statements. Even if clearly disproved, no damaging blame attaches to the politician who makes them. He, if adroit (and the politician who is not has missed his calling), will not be found to have perpetrated an absolute falsehood. There are always plenty of political rumors afloat, and one of these can be easily dressed up and given out as "a matter of common knowledge," or "what everybody is saying, you know." The success of such devices shows that mankind has not yet outgrown its pristine credulity.

Instinctive Criminality.—In a paper on instinctive criminality, Dr. S. A. K. Strahan holds that the criminal belongs to a decaying race, and is only found in families whose other members show signs of degradation; in fact, it is only one of the many signs of family decay. Besides being hereditary, criminality is interchangeable with other degenerate conditions, such as idiocy, epilepsy, suicide, insanity, scrofula, etc.; and it is a chance whether the insanity or drunkenness, say, of the parent, will appear as such in the child or be transmuted in transmission to one or other of the alternate degenerate conditions. The present system of treatment has proved a disastrous failure; short periods of punishment can have no effect, either curative or deterrent. Everything points in the direction of prolonged or indefinite confinement in industrial penitentiaries.

Oscillations in Latitude.—At the recent anniversary meeting of the Royal Society, the president, Sir William Thomson, spoke of the investigation of oscillations of latitude which has been instituted under the auspices of the International Geodetic Union. Comparative observations have been begun at Berlin, and at Honolulu, which is very near the opposite meridian to Berlin. The first several hundred determinations of latitude made at Honolulu during three months of a proposed year of observations, compared with the corresponding results at Berlin, showed that the latitude during that time had increased in Berlin and decreased at Honolulu by about one third of a second. "Thus we have decisive demonstration that motion, relatively to the earth, of the earth's instantaneous axis of rotation, is the cause of variations of latitude which have been observed at Berlin, Greenwich, and other observatories, and which can not be wholly attributed to errors of observation." This, Prof. Foerster remarks, gives observational proof of a conclusion which the author had expressed in 1876, to the effect that irregular movements of the earth's axis to the extent of half a second may be produced by the temporary changes of sea-level due to meteorological causes. It is proposed that four permanent stations for regular and continued observation of latitude at places of approximately equal latitude and on meridians approximately 90° apart, be established under the auspices of the International Geodetic Union. The reason for this arrangement is, that a change in the instantaneous axis of rotation in the direction perpendicular to the meridain of any one place would not alter its latitude, but would alter the latitude of a place 90° from it in longitude by an amount equal to the angular change of the position of the axis. Thus two stations in meridians differing by 90° would theoretically suffice, by observations of latitude, to determine the changes in the position of the instantaneous axis; but differential results, such as those already obtained between Berlin and Honolulu, differing by approximately 180° in longitude, are necessary for eliminating errors of observation sufficiently to give satisfactory and useful results.

Swedish Wood and Iron.—According to our minister in Stockholm, the two great products of Sweden after agriculture are wood and iron. The Norland is still covered for the most part with an extensive black forest, consisting largely of pine and spruce. Upon the great water-shed called the *fjeld* or *Kölen* (the keel of the country likened to a boat turned bottom upward) stand the chief timber forests; and extensive lumbering operations are carried on along the numerous rivers and their tributaries that flow thence. At the mouths of most of the rivers are towns which take their names as well as their business and prosperity from the streams where are large saw-mills. Lumber operations are also conducted south of Stockholm on both coasts, and there is a considerable export from Gothenburg; but the great bulk of the timber is cut and sawn in Norland, and eighty-five per cent of the lumber exports come from the north of Stockholm. The Swedish lumber trade has assumed its present importance only within the present century, and in fact during the past thirty years. More than one quarter of the wooded area of Sweden, or 14,300,000 acres, belongs to the crown. The forests are supervised with great care, and all Sweden is divided into forest districts, and these, in turn, into *revirs*. Each district is under the supervision of a chief forest inspector, and each *revir* is guarded by a forest ranger and a number of under-keepers. Our minister thinks that the vast forests of Sweden will be preserved and maintained substantially as they stand to-day, and that Sweden's lumber export—her greatest source of revenue—will be maintained and kept good for ages to come. The Swedish iron, celebrated throughout the world, is soft and ductile, and preserves great pliability and strength. It still furnishes the raw material for the best tools and weapons, the finest springs and drawn wire, and the best kind of nails for riveting and clinching. Its excellence depends partly on its being free from phosphorus and sulphur, and partly on the superior manner of the smelting, which is done with charcoal. The supply of ore is practically inexhaustible. It is found all over the country; it occurs in the thick strata of the rock and forms the bulk of great mountains in various parts of the kingdom. The largest of these iron mountains is Gellivare, situated in Swedish Lapland, beyond the Arctic Circle. The ore occurs here chiefly in four gigantic strata, and covers so large an area that it is estimated that, if only one metre in depth is taken out a year, the yield would be 943,600 tons, nearly equal to the amount now produced by all the mines in Sweden. The ore contains seventy per cent of iron. Much of it, however, contains apatite, and in such large quantities that the question of turning to account the phosphoric acid held in that mineral is entertained. Iron is chiefly mined in central Sweden, but the best iron comes from the Dannemora mines, a little east of the chief area. Besides making the rougher forms of iron, the Swedes build iron steamships of fine quality, and are very skillful in the manufacture of cutlery, for which they have a dozen factories.

Suspended Matter in Flame.—In a communication to the Royal Society of Edinburgh, Mr. G. C. Stokes announces that he has secured an optical proof of the existence of suspended matter in flames. Passing a beam of sunlight, condensed by a lens, through the flame of a candle, he noticed that where the cone of rays cut the luminous envelope there were two patches of light brighter than the general flame, which were evidently due to sunlight scattered by matter in the envelope which was in a state of suspension. The patches corresponded in area to the intersection of the double cone by the envelope, and their thickness was insensibly small. Within the envelope, as well as outside, there was none of this scattering. When the beam was passed through the blue base of the flame, there was no scattered light. A luminous gas-flame showed the patches indicating scattered light like the flame of a candle, but less copiously. They were not seen in a Bunsen flame or in the flame of alcohol, but were well seen in the luminous flame of ether. The phenomenon shows the separation of carbon, associated, it may be, with some hydrogen, in the flame, and the extreme thinness of the layer which this forms. It shows, too, the mode of separation of the carbon—namely, that it is due to the action of heat on the volatile hydrocarbon or vapor of ether, as the case may be. At the base, where there is a plentiful supply of oxygen, the molecules are burned at once. Higher up, the heated products of combustion have time to decompose the combustible vapor before it gets oxygen enough to burn it. Since makiug his communication, Prof. Stokes has found that he was anticipated in part of his observation in a paper published a few years ago by Mr. Busch.

The Vlachs of Turkey.—The Vlachs of Turkey are described by Mrs. L. M. J. Garnett, in her Women of Turkey and their Folk Lore, as a nomadic people, shepherds or traders, who leave a great deal of responsibility to their wives. The women, besides managing their households, have to cultivate the vineyard and garden, herd the sheep, shear the wool, weave the cloth, and generally perform every variety of labor, "not the least arduous part of which is the assiduous attention required by their lords and masters when they return from their wanderings for a spell of domestic repose." The customs of this people are a mixture of Greek and Roman tradition. They belong to the Orthodox Church, and their ceremonies at birth and baptism are essentially similar to those of the Greeks. The marriage forms (save the sacred rite) are more like the Roman. These ceremonies are very minute and protracted; and "it must require a liberal education to master all the details of a Vlach or Greek wedding: to find the five-twigged branch and decorate it with an apple and tufts of red wool and fix it on the top of the bride's house; to prepare the ring-cake and then engage in a hot struggle for it. . . . The unfortunate Vlach must be perpetually trying to remember what function he or she has to perform each week. On New Year's day come the children with olive branches; on the morrow every visitor must throw salt on the fire, and then put an egg in the hen-house in prayerful hope that a considerate fowl may sit on it; in February all the dogs must be thoroughly beaten as a precaution against hydrophobia—indeed, there is always some ceremony to the fore, generally accompanied by songs and ballads." To the Greek, too, every accident has its interpretation. To drop oil is unlucky, but wine may be spilt with advantage; a rainbow over a cemetery means a coming epidemic; and the recipe concerning "the hair of the dog that bit you" is practically enforced by inserting tufts of the dog's hair in the wound made by his teeth.

India-rubber Trees.—India-rubber trees, according to W. R. Fisher, in Nature, are extensively cultivated in flourishing plantations in the Charduar forest, at the foot of the Himalaya Mountains, in Assam. The climate of the place is essentially damp. The forest contains a great number of woody species, both evergreen and deciduous, with a few enormous old rubber trees disseminated through it. Trees have been measured here 129 feet high, with a girth around the principal aërial roots of 138 feet, while the girth of the crown was 611 feet. As rubber trees can not stand shade, and the seeds damp off unless fully exposed to light and well drained, the natural reproduction of *Ficus elastica* generally takes place in the forks of stag-headed or lightly foliaged trees high up in the crown, where the seeds are left by birds; and from such a site the aërial roots in process of time descend to the ground and develop into a vast hollow cylinder around the foster-stem, and it is speedily inclosed and killed by the vigorous crown of the epiphyte, which eventually replaces it in the forest. In its epiphytic growth the aërial roots of *Ficus elastica* may take several years to reach the ground, but, once well rooted, nothing can probably surpass it in its native habitat for rapidity of growth and vigor. At first attempts were made to propagate by cuttings, which struck easily; but it was soon discovered that rubber seed germinates freely on well-drained beds covered with powdered charcoal or brick-dust, and that the seedlings, though at first as small as cress, grew rapidly, and became about two feet high in twelve months, and were much hardier against drought than plants produced from cuttings. The base of the stem of the seedlings swells out like a carrot, and this probably enables them to tide through the dry season in safety.

Tin Production of Cornwall.—A review, by Mr. J. H. Collins, of the tin production of Cornwall during seven centuries shows how rapidly it has grown. An extensive commerce in the metal was already carried on in extremely ancient times. In the thirteenth century of our era, 486 tons of tin were taken annually from the mines; in the fourteenth century, 828 tons; in the fifteenth century, 732 tons; in the sixteenth century, 802 tons; in the seventeenth century, 1,300 tons; in the eighteenth century, 3,938 tons; and in the nineteenth century (ninety years), 8,795 tons. The total quantity raised is not less than 1,938,800 tons. The mean average for the fifty years ending in 1849 was 6,008 tons per year, and for the fifty years ending in 1889, 12,278 tons per year. This remarkable increase during the last forty years has been in the face of extensive production in the Strait of Malacca and Australia. Of sudden advances in production, the most noticeable, in the latter part of the fourteenth century, was probably occasioned by the great demand for bell-metal. The second period of rapid advance was in the latter part of the eighteenth century, when bronze was commonly used for cannon. The third period is that of the general use of tinned metals.

NOTES.

Involuntary Movements.—The article on Involuntary Movements, by Prof. Jastrow, published in the April number, will appear in a more extended form in the forthcoming issue of the American Journal of Psychology.

A promising account is given of the copper mines of French Congo. They lie in the district around the source of the Ludima-Niadi, about two days south of Stéphanieville. The ore, a malachite, is brought to the surface by about three hundred and fifty negroes, whose methods of work are extremely simple. They reach the mineral by digging out, with implements of hard wood, holes or shafts three feet wide and twice as deep. The malachite is broken on the ground, and afterward when pulverized is put into a furnace on a tray with charcoal, on which bellows are made to play. In due time the tray is removed by means of pieces of bamboo and the metal is poured into sand molds. The entire district is said to be rich in copper, and masses of malachite are frequently found in the Ludima.

It has been shown by Mr. Aitken that the presence of dust, affording a free surface on which vapor may condense, is essential to the production of fog. The specific action of the dust varies considerably according to its composition and to the size and abundance of the particles present. Sulphur burned in the air is an active fog-producer; so are salt and hygroscopic bodies generally. Non-hygroscopic bodies also produce it, especially if they are good radiators of heat. The exceedingly minute amount of matter capable of inducing fog is a noticeable feature in the investigation. The condensation of moisture upon dust offers an effective process for removing all kinds of impurities from the air, for the floaticles are weighted by the moisture settling upon them.

OBITUARY NOTES.

Sir Andrew Crombie Ramsay, an eminent British geologist of the last generation, died December 9, 1891, at the age of about seventy-six years. He was first brought into notice by a geological model of the isle of Arran, constructed from his own survey, which he exhibited at the Glasgow meeting of the British Association in 1840. He was afterward appointed, through the influence of Sir Roderick I. Murchison, on the Geological Survey, with which he labored in Wales. His monograph on the geology of North Wales presented the results of his labors in this field. Between 1848 and 1851 he was Professor of Geology in University College, London; in 1851 he was chosen one of the professors of the newly founded School of Mines. As a geological lecturer, the Athenæum says, he probably never had an equal. He retired from active life about ten years ago.

Herr J. W. Ewald, a well-known German geologist, died in Berlin in December, 1891, aged eighty-one years. He was the traveling companion of Leopold von Buch in his scientific expedition; succeeded him as a member of the Berlin Academy of Sciences; and issued, in conjunction with Roth and Eck, a collected edition of his works.

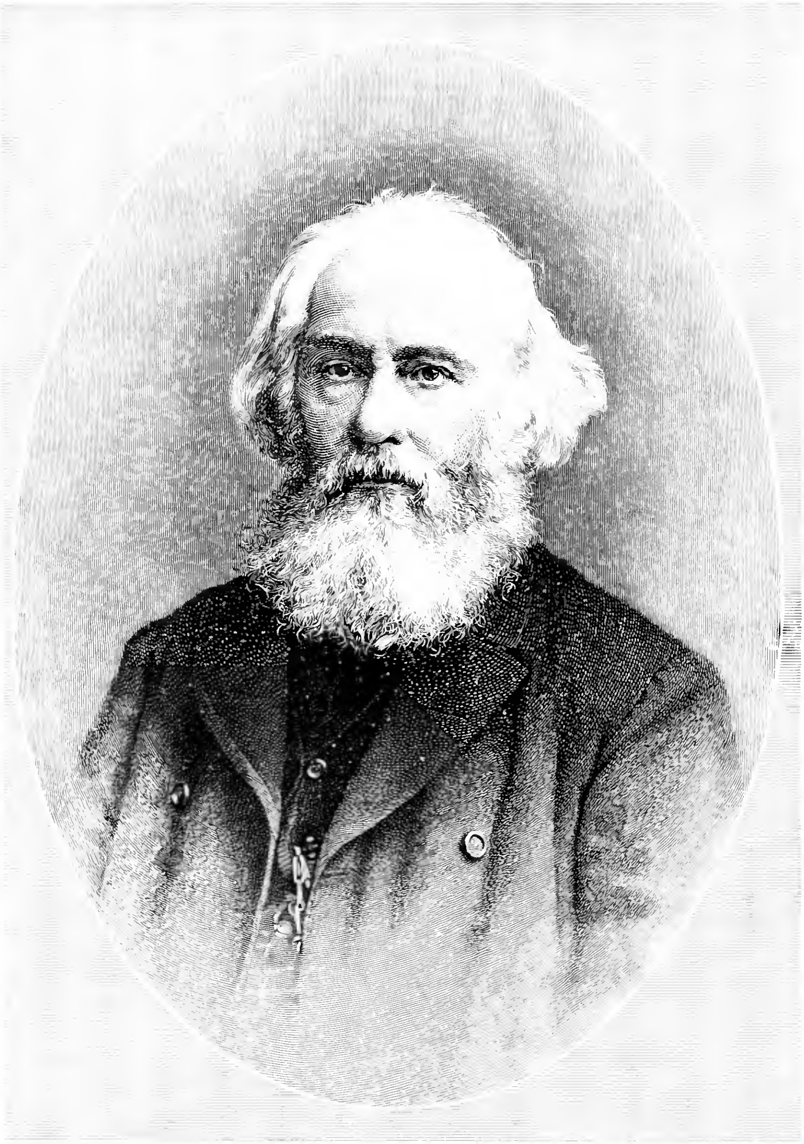
Mr. Henry W. Bates, an English naturalist, died February 27th, in the sixty-eighth year of his age. In 1848 he went with Alfred Russel Wallace on a natural-history exploration of the Amazons, where he remained for several years after Mr. Wallace returned home. On his return he published a paper on "mimetic resemblance" in animals, recording some of the first observations made on that subject. After 1864 he was Assistant Secretary of the Royal Geographical Society, and editor of its journal and proceedings. He was the author of the books, The Naturalist on the River Amazon, Illustrated Travels, The German Arctic Expedition of 1869–'70, and Central America, West Indies, and South America.

The death is announced from St. Petersburg of the African traveler and naturalist, Dr. Wilhelm Junker. He made several valuable explorations in central Africa, in the country west of the Nile, and between the Bahr-el-Gazel and the equator; among the Niam Niams; and of the course of the river Welle.

Prof. William Guy Peck, of Columbia College, died suddenly, February 7th, in the seventy-third year of his age. Besides several text-books in mathematics, he published The Elements of Mechanics in 1859, an edition of Ganot's Physics in 1860, and was joint editor with Charles Davies of the Mathematical Dictionary and Cyclopædia of the Mathematical Sciences.

John Francis Williams, Professor of Geology and Mineralogy in Cornell University, who died last November, was only twenty-nine years old; yet he had, after taking his degree at the Rensselaer Polytechnic Institute, studied three years at Göttingen, acted as assistant to Dr. Klein in Berlin, served as curator of the mineralogical and geological collection of Pratt Institute, participated in an important part of the State survey of Arkansas, collecting minerals for a complete report on the mineralogy and petrography of the State, and published several important papers and two (including one in press) large works on subjects within the sphere of his specialty.

Prof. Sereno Watson, Curator of the Harvard Herbarium, died in Cambridge, Mass., March 9th, in the seventy-second year of his age. He was graduated from Yale College in 1847; served as a tutor in Iowa University; studied medicine and practiced it for two years; was engaged in business in Alabama, where he also paid some attention to botany; afterward co-operated in literary work with Dr. Henry Barnard at Hartford, Conn.; was botanist of the surveying expedition of the fortieth parallel, or Clarence King Expedition; and after 1870 passed most of his time at Cambridge in the study of the North American flora. He published an Index to North American Botany; in conjunction with Prof. Gray and Prof. Brewer, the Botany of California; completed the work of Lesquereux and James on American Mosses; and after Prof. Gray's death became curator of the university herbarium, and continued the editing of the Synoptical Flora of North America. He was botanical editor of the earlier volumes of the Century Dictionary, and published many papers in the Proceedings of the American Academy of Arts and Sciences.



WILLIAM HUGGINS

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XVI. THE RETREAT OF THEOLOGY IN THE GALILEO CASE.

By ANDREW DICKSON WHITE, LL. D., L. H. D.,

EX-PRESIDENT OF CORNELL UNIVERSITY.

ANY history of the victory of astronomical science over theology would be incomplete without some account of the retreat made by the Church from all its former positions in the Galileo case.

The retreat of the Protestant theologians was not difficult. A little skillful warping of Scripture, and a little skillful use of that time-honored phrase attributed to Cardinal Baronius, that the Bible is given to teach us, not how the heavens go, but how men go to heaven, sufficed.

But in the older Church it was far less easy. The retreat of the sacro-scientific army of Church apologists lasted through two centuries.

In spite of all that has been said by these apologists, there no longer remains the shadow of a doubt that the papal infallibility was committed fully and irrevocably against the double revolution of the earth. As the documents of Galileo's trial now published show, Paul V pushed on with all his might the condemnation of Galileo in 1616, and the condemnation in that same year of the works of Copernicus and all others teaching the motion of the earth around its own axis and around the sun. So, too, in the condemnation of Galileo in 1633, and in all the proceedings which led up to it and which followed it, Urban VIII was the central figure. Without his sanction no action could have been taken.

True, the Pope did not formally sign the degree against the Copernican theory *then*; but this came later: in 1664 Alexander VII prefixed to the Index containing the condemnations of the works of Copernicus and Galileo and "all books which affirm the motion of the earth," a papal bull signed by himself, binding the contents of the Index upon the consciences of the faithful. This bull confirmed and approved in express terms, finally, decisively, and infallibly, the condemnation of "all books teaching the movement of the earth and the stability of the sun." *

The position of the mother Church, then, was especially difficult. The first important move in retreat by the apologists was the statement that Galileo was condemned, not because he affirmed the motion of the earth, but because he supported it from Scripture. There was a slight appearance of truth in this. Undoubtedly, Galileo's letters to Castelli and the grand duchess, in which he attempted to show that his astronomical doctrines were not opposed to Scripture, gave a new stir to religious bigotry. For a considerable time, then, this quibble served its purpose; even a hundred and fifty years after Galileo's condemnation it was renewed by the Protestant, Mallet du Pan, in his wish to gain favor from the older Church.

But nothing can be more absurd, in the light of the original documents recently brought out of the Vatican archives, than to make this contention now. The letters of Galileo to Castelli and the grand duchess were not published until after the condemnation; and, although the Archbishop of Pisa had endeavored to use them against him, they were but casually mentioned in 1616, and entirely left out of view in 1633. What was condemned in 1616 by the Sacred Congregation held in the presence of Pope Paul V, as "*absurd, false in theology, and heretical, because absolutely contrary to Holy Scripture*," was the proposition that "*the sun is the center about which the earth revolves*"; and what was condemned as "*absurd, false in philosophy, and from a theologic point of view, at least, opposed to the true faith*," was the proposition that "*the earth is not the center of the universe and immovable, but has a diurnal motion.*"

And again, what Galileo was made, by express order of Pope Urban, and by the action of the Inquisition under threat of torture, to abjure in 1633 was "*the error and heresy of the movement of the earth.*"

What the Index condemned under sanction of the bull issued by Alexander VII in 1664 was, "*all books teaching the movement of the earth and the stability of the sun.*"

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* See Rev. William W. Roberts, The Pontifical Decrees against the Doctrine of the Earth's Movement, London, 1885, p. 94; and for the text of the papal bull, Speculatores domus Israel, pp. 132, 133. See also St. George Mivart's article in the Nineteenth Century for July, 1885. For the authentic publication of the bull, see preface to the Index of 1664, where the bull appears, signed by the Pope. The Rev. Mr. Roberts and Mr. St. George Mivart are Roman Catholics, and both acknowledge that the papal sanction was fully given.

What the Index, prefaced by papal bulls, binding its contents upon the consciences of the faithful, for two hundred years steadily condemned, was "*all books which affirm the motion of the earth.*"

Not one of these condemnations was directed against Galileo "for reconciling his ideas with Scripture." *

Having been dislodged from this point, the Church apologists sought cover under the statement that Galileo was condemned, not for heresy, but for contumacy, and for wanting in respect to the Pope.

There was a slight chance, also, for this quibble: no doubt Urban VIII, one of the haughtiest of pontiffs, was induced by Galileo's enemies to think that he had been treated with some lack of proper etiquette: first, by Galileo's adhesion to his own doctrines after his condemnation in 1616; and, next, by his supposed reference in the Dialogue of 1632 to the arguments which the Pope had used against him.

But it would seem to be a very poor service rendered to the doctrine of papal infallibility to claim that a decision, so immense in its consequences, could be influenced by the personal resentment of the reigning pontiff.

Again, as to the first point, the very language of the various sentences shows the folly of this assertion; these sentences speak steadily of "heresy," and never of "contumacy." As to the last point, the display of the original documents settled that forever. They show Galileo from first to last as most submissive toward the Pope, and patient under the papal arguments and exactions. He had, indeed, expressed his anger at times against his traducers; but to hold this the cause of the judgment against him is to degrade the whole proceedings, and to convict Paul V, Urban VIII, Bellarmin, the other theologians, and the Inquisition, of direct falsehood, since they assigned entirely different reasons for their conduct. From this position, therefore, the assailants retreated.†

The next rally was made about the statement that the persecution of Galileo was the result of a quarrel between Aristotelian professors on one side and professors favoring the experimental

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* See the original trial documents, copied carefully from the Vatican manuscripts; see the Roman Catholic authority, L'Epinois, especially p. 35, where the principal document is given in its original Latin; see, also, Gebler, Die Acten des Galilei'schen Processes, for still more complete copies of the same documents. For minute information regarding these documents and their publication, see Favaro, Miscellanea Galileana Inedita, forming vol. xxii, part iii, of the Memoirs of the Venetian Institute for 1887, and especially pp. 891 and following.

† The invention of the "contumacy" quibble seems due to Monsignor Marini, who appears also to have manipulated the original documents to prove it. Even Whewell appears to have been somewhat misled by him, but Whewell wrote before L'Epinois had shown all the documents, and under the supposition that Marini was an honest man.

method on the other. But this position was attacked and carried by a very simple statement. If the divine guidance of the Church is such that it can be dragged into a professorial squabble, and made the tool of a faction in bringing about a most disastrous condemnation of a proved truth, how did the Church at that time differ from any human organization sunk into decrepitude, managed nominally by simpletons, but really by schemers? If that argument be true, the condition of the Church was worse than its enemies have declared it: amid the jeers of an unfeeling world the apologists sought new shelter.

The next point at which a stand was made was the assertion that the condemnation of Galileo was "provisory"; but this proved a more treacherous shelter than the other. When doctrines have been solemnly declared, as those of Galileo were solemnly declared by the highest authority in the Church, "contrary to the sacred Scriptures," "opposed to the true faith," and "false and absurd in theology and philosophy;"—to say that such declarations are "provisory," is to say that the truth held by the Church is not immutable; from this, then, the apologists retreated.*

Still another contention was made—in some respects more curious than any other;—it was, mainly, that Galileo "was no more a victim of Catholics than of Protestants; for they more than the Catholic theologians impelled the Pope to the action taken." †

But if Protestantism could force the papal hand in a matter of this magnitude—involving vast questions of belief and far-reaching questions of policy—what becomes of "inerrancy," of special protection and guidance of the papal authority in matters of faith?

While this retreat from position to position was going on, there was a constant discharge of small-arms, in the shape of innuendoes, hints, and sophistries: every effort was made to blacken Galileo's private character; the irregularities of his early life were dragged forth, and stress even was laid upon breaches of etiquette; but this succeeded so poorly that even as far back as 1850 it was thought necessary to cover this retreat by some more careful strategy.

This strategy is instructive. The original documents of the Galileo trial had been brought during the Napoleonic conquests to Paris; but in 1846 they were returned to Rome by the French Government, on the express pledge by the papal authorities that

* This argument also seems to have been foisted upon the world by the wily Monsignor Marini.

† See the Rev. A. M. Kirsch on Professor Huxley and Evolution, in The American Catholic Quarterly, October, 1877. The article is, as a whole, remarkably fair-minded, and in the main just, as to the Protestant attitude, and as to the causes underlying the whole action against Galileo.

they should be published. In 1850, after various delays on various pretexts, the long-expected publication appeared. The personage charged with presenting them to the world was Monsignor Marini. This ecclesiastic was of a kind which has too often afflicted both the Church and the world at large. Despite the solemn promise of the papal court, the wily Marini became the instrument of the Roman authorities in evading the promise. By suppressing a document here, and interpolating a statement there, he managed to give plausible standing-ground for nearly every important sophistry ever broached to save the infallibility of the Church and destroy the reputation of Galileo. He it was who supported the idea that Galileo was "condemned, not for heresy, but for contumacy," and various other assertions as groundless.

The first effect of Monsignor Marini's book seemed useful in covering the retreat of the Church apologists. Aided by him, such vigorous writers as Ward were able to throw up temporary intrenchments between the Roman authorities and the indignation of the world.

But some time later came an investigator very different from Monsignor Marini. This was a Frenchman, M. L'Epinois. Like Marini, L'Epinois was devoted to the Church; but, unlike Marini, he could not lie. Having obtained access in 1867 to the Galileo documents at the Vatican, he published fully several of the most important, without suppression or piously-fraudulent manipulation. This made all the intrenchments based upon Marini's statements untenable. Another retreat had to be made.

And now came the most desperate effort of all. The apologetic army, reviving an idea which the popes and Church had spurned for centuries, declared that the popes *as popes* had never condemned the doctrines of Copernicus and Galileo; that they had condemned them as men simply; that therefore the Church had never been committed to them; that the condemnation was made by the cardinals of the Inquisition and Index; and that the Pope had evidently been restrained by interposition of Providence from signing their condemnation. Nothing could show the desperation of the retreating party better than jugglery like this. The facts are, that in the official account of the condemnation by Bellarmin, in 1616, he declares distinctly that he makes this condemnation "in the name of his Holiness the Pope." *

Again, from Pope Urban downward, among the Church authorities of the seventeenth century, the decision was always acknowledged to be made by the Pope and the Church. Urban VIII spoke of that of 1616 as made by Pope Paul V and the Church, and of that of 1633 as made by himself and the Church.

* See the citation from the Vatican manuscript given in Gebler, p. 78.

Pope Alexander VII in 1664, in his bull "Speculatores," solemnly sanctioned the condemnation of all books affirming the earth's movement.*

When Gassendi attempted to raise the point that the decision against Copernicus and Galileo was not sanctioned by the Church as such, an eminent theological authority, Father Lecazre, rector of the College of Dijon, publicly contradicted him, and declared that it "was not certain cardinals, but the supreme authority of the Church," that had condemned Galileo; and to this statement the Pope and other Church authorities gave consent either openly or by silence. When Descartes and others attempted to raise the same point, they were treated with contempt. Father Castelli, who had devoted himself to Galileo, and knew to his cost just what the condemnation meant and who made it, takes it for granted in his letter to the papal authorities that it was made by the Church. Cardinal Querenghi, in his letters; the ambassador Guicciardini, in his dispatches; Polacco, in his refutation; the historian Viviani, in his biography of Galileo—all writing under Church inspection and approval at the time, took the view that the Pope and Church condemned Galileo, and this was never denied at Rome. The Inquisition itself, backed by the greatest theologian of the time, Bellarmin, took the same view. Not only does he declare that he makes the condemnation "in the name of his Holiness the Pope," but we have the Roman Index, containing the condemnation for nearly two hundred years, prefaced by a solemn bull of the reigning Pope binding this condemnation on the consciences of the whole Church, and declaring year after year that "all books which affirm the motion of the earth" are damnable. To attempt to face all this, added to the fact that Galileo was required to abjure "the heresy of the movement of the earth" by written order of the Pope, was soon seen to be impossible. Against the assertion that the Pope was not responsible we have all this mass of testimony, and the bull of Alexander VII in 1664.†

This contention, then, was at last utterly given up by honest

* For references by Urban VIII to the condemnation as made by Pope Paul V, see pp. 136, 144, and elsewhere in Martin, who much against his will is forced to allow this. See also Roberts, Pontifical Decrees against the Earth's Movement, and St. George Mivart's article, as above quoted; also Reusch, Der Index verbotenen Bücher, Bonn, 1885, vol. ii, pp. 29 *et seq.*

† For Lecazre's answer to Gassendi, see Martin, pp. 146, 147. For the attempt to make the crime of Galileo a breach of etiquette, see Dublin Review, as above. Whewell, vol. i, p. 283. Citation from Marini: "Galileo was punished for trifling with the authorities, to which he refused to submit, and was punished for obstinate contumacy, not heresy." The sufficient answer to all this is that the words of the inflexible sentence designating the condemned books are "Libri omnes qui affirmant telluris motum." See Bertrand, p. 59. As to the idea that "Galileo was punished, not for his opinion, but for basing it on Script-

Catholics themselves. In 1870 a Roman Catholic clergyman in England, the Rev. Mr. Roberts, evidently thinking that the time had come to tell the truth, published a book entitled The Pontifical Decrees against the Earth's Movement. In this were exhibited the incontrovertible evidences that the papacy had committed itself and its infallibility fully against the movement of the earth. The Rev. Mr. Roberts showed from the original record that Pope Paul V, in 1616, had presided over the tribunal condemning the doctrine of the earth's movement, and ordering Galileo to give up the opinion. He showed that Pope Urban VIII, in 1633, pressed on, directed, and promulgated the final condemnation, making himself in all these ways responsible for it. And, finally, he showed that Pope Alexander VII, in 1664, by his bull,—Speculatores domus Israel,—attached to the Index, condemning "all books which affirm the motion of the earth," had absolutely pledged the papal infallibility against the earth's movement. He also confessed that under the rules laid down by the highest authorities in the Church, and especially by Sixtus V and Pius IX, there was no escape from this conclusion.

Various theologians attempted to evade the force of the argument. Some, like Dr. Ward and Bouix, took refuge in verbal niceties; some, like Dr. Jeremiah Murphy, comforted themselves with declamation. The only result was, that in 1885 came another edition of the Rev. Mr. Roberts's work, even more cogent than the first; and, besides this, an essay by that eminent Catholic, St. George Mivart, acknowledging the Rev. Mr. Roberts's position to be impregnable, and declaring virtually that the Almighty allowed Pope and Church to fall into complete error regarding the Copernican theory, in order to teach them that science lies outside their province, and that the true priesthood of scientific truth rests with scientific investigators alone.*

In spite, then, of all casuistry and special pleading, this sturdy honesty ended the controversy among Catholics themselves, so far as fair-minded men are concerned.

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ure," the answer may be found in the Roman Index of 1704, in which are noted for condemnation "Libri omnes docentes mobilitatem terræ et immobilitatem solis." For the way in which, when it was found convenient in argument, Church apologists insisted that it *was* "the Supreme Chief of the Church by a pontifical decree and not certain cardinals" who condemned Galileo and his doctrine, see Father Lecazre's letter to Gassendi, in Flammarion, Pluralité des Mondes, p. 427, and Urban VIII's own declarations as given by Martin. For the way in which, when necessary, Church apologists asserted the very contrary of this, declaring that "it was issued in a doctrinal decree of the Congregation of the Index, and *not* as the Holy Father's teaching," see Dublin Review, September, 1865.

* For this crushing answer, and by two eminent Roman Catholics, to the sophistries cited—an answer which does infinitely more credit to the older Church than all the perverted ingenuity used in concealing the truth or breaking the force of it—see Roberts and St. George Mivart, as already cited.

In recalling it at this day there stand out from its later phases two efforts at compromise especially instructive, as showing the embarrassment of militant theology in the nineteenth century.

The first of these was made by John Henry Newman in the days when he was hovering between the Anglican and Roman Churches. In one of his sermons before the University of Oxford he spoke as follows:

"Scripture says that the sun moves and the earth is stationary, and science that the earth moves and the sun is comparatively at rest. How can we determine which of these opposite statements is the very truth till we know what motion is? If our idea of motion is but an accidental result of our present senses, neither proposition is true and both are true: neither true philosophically; both true for certain practical purposes in the system in which they are respectively found."

In all anti-theological literature there is no utterance more hopelessly skeptical. And for what were the youth of Oxford led into such bottomless depths of disbelief as to any real existence of truth or any real foundation for it? Simply to save an outworn system of interpretation into which the gifted preacher happened to be born.

The other utterance was suggested by De Bonald and developed in the Dublin Review, as is understood, by one of Newman's associates. This argument was nothing less than an attempt to retreat under the charge of deception against the Almighty himself. It is as follows: "But it may well be doubted whether the Church did retard the progress of scientific truth. What retarded it was the circumstance that God has thought fit to express many texts of Scripture in words which have every appearance of denying the earth's motion. But it is God who did this, not the Church; and, moreover, since he saw fit so to act as to retard the progress of scientific truth, it would be little to her discredit, even if it were true, that she had followed his example."

This argument, like Mr. Gosse's famous attempt to reconcile geology to Genesis—by supposing that for some inscrutable purpose God deliberately deceived the thinking world by giving to the earth all the appearances of development through long periods of time, while really creating it in six days, each of an evening and a morning—seems only to have awakened the amazed pity of thinking men. This, like the argument of Newman, was the last desperate effort of Anglican and Roman divines to save something from the wreckage of theology.*

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* For the quotation from Newman, see his Sermons on the Theory of Religious Belief, sermon xiv, cited by Bishop Goodwin in Contemporary Review for January, 1892. For the attempt to take the blame off the shoulders of both Pope and cardinals, and place it upon the Almighty, see the article above cited, in the Dublin Review, September, 1865, p. 419,

All these well-meaning defenders of the faith have but wrought into the hearts of great numbers of thinking men the idea that there is a necessary antagonism between science and religion. Like the landsman who lashes himself to the anchor of the sinking ship, they have attached Christianity by the strongest cords of logic which they could spin to these mistaken ideas in science, and, could they have had their way, the advance of knowledge would have ingulfed both together.

On the other hand, what has science done for religion? Simply this: Copernicus, escaping persecution only by death; Giordano Bruno, burned alive as a monster of impiety; Galileo, imprisoned and humiliated as the worst of misbelievers; Kepler, hunted alike by Protestant and Catholic—gave to religion new foundations, new and more ennobling conceptions.

Under the old system, that princely astronomer, Alphonso of Castile, seeing the inadequacy of the Ptolemaic theory, yet knowing no other, startled Europe with the blasphemy that, if he had been present at creation, he could have suggested a better order of the heavenly bodies. Under the new system, Kepler, filled with a religious spirit, exclaimed, "I do think the thoughts of God." The difference in religious spirit between these two men marks the conquest made in this long struggle by Science for Religion.*

Nothing is more unjust than to cast especial blame for all this resistance to science upon the Roman Church. The Protestant Church, though rarely able to be so severe, has been more blameworthy. The persecution of Galileo and his compeers by the older Church was mainly at the beginning of the seventeenth century; the persecution of Robertson Smith, and Winchell, and Woodrow, and Toy, and the young professors at Beyrout, by various Protestant authorities, was near the end of the nineteenth century. Those earlier persecutions by Catholicism were strictly in accordance with principles held at that time by all religionists, Catholic and Protestant, throughout the world; these later persecutions by Protestants were in defiance of principles which all Christendom to-day holds or pretends to hold, and none make louder claim to hold them than the very sects which persecuted these eminent Christian men of our day, whose crime was that they were intelligent enough to accept the science of their time, and honest enough to acknowledge it.

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and July, 1871, pp. 157 *et seq.* For a good summary of the various attempts, and for replies to them in a spirit of judicial fairness, see Th. Martin, Vie de Galilée, though there is some special pleading to save the infallibility of Pope and Church. The bibliography at the close is very valuable. For details of Mr. Gosse's theory, as developed in his Omphalos, see my chapter on Geology.

* As a pendant to this ejaculation of Kepler may be cited the words of Linnæus: "Deum omnipotentem a tergo transeuntem vidi et obstupui."

Nor can Protestantism rightly taunt Catholicism for excluding knowledge of astronomical truths from European Catholic universities in the seventeenth and eighteenth centuries, while real knowledge of geological and biological and anthropological truth is denied or pitifully diluted in so many American Protestant colleges and universities in the nineteenth century.

Nor has Protestantism the right to point with scorn to the Catholic "Index," and call attention to the fact that nearly every really important book in the last three centuries has been forbidden by it, so long as young men in so many American Protestant universities and colleges, and university extension schemes, and "approved courses of reading," are filled with "ecclesiastical pap" rather than with real thought, and directed to the works of "solemnly constituted impostors," while they are studiously kept away from such leaders in modern thought as Darwin, Spencer, Huxley, Draper, and Lecky.

It may indeed be justly claimed by Protestantism that some of the former strongholds of her bigotry have become liberalized; but, on the other hand, Catholicism can point to the fact that Pope Leo XIII, now happily reigning, has made a noble change as regards open dealing with documents. The days of Monsignor Marini, it may be hoped, are gone. The Vatican Library, with its masses of historical material, has been thrown open to Protestant and Catholic scholars alike, and this privilege has been freely used by men representing all shades of religious thought.

As to the older errors, the whole civilized world was at fault—Protestant as well as Catholic. It was not the fault of religion; it was the fault of that short-sighted linking of theological dogmas to scriptural texts which, in utter defiance of the words and works of the Blessed Founder of Christianity, narrow-minded, loud-voiced men are ever prone to substitute for religion. Justly is it said by one of the most eminent among contemporary Anglican divines that "it is because they have mistaken the dawn for a conflagration that theologians have so often been foes of light." *

* For an exceedingly striking statement, by a Roman Catholic historian of genius, as to the *popular* demand for persecution and the pressure of the lower strata in ecclesiastical organizations for cruel measures, see Balmès's Le Protestantisme comparé au Catholicisme, etc., fourth edition, Paris, 1855, vol. ii. Archbishop Spaulding has something of the same sort in his Miscellanies. L'Epinois, Galilée, pp. 22 *et seq.*, stretches this as far as possible to save the reputation of the Church in the Galileo matter. As to the various branches of the Protestant Church in England and the United States, it is a matter of notoriety that the smug, well-to-do laymen, whether elders, deacons, or vestrymen, are, as a rule, far more prone to heresy-hunting than are their better-educated pastors. As to the cases of Messrs. Winchell, Woodrow, Toy, and the professors at Beyrout, with details, see the chapter in this series on The Fall of Man and Anthropology. Among Protestant historians who have been recently allowed full and free examination of the treasures in the Vatican Library, and even those involving questions between Catholicism and Protestant-

FIRST ACTIONS OF WOUNDED SOLDIERS.

By GEORGE L. KILMER.

AFTER observing for thirty years the questions of the curious on the subject of battle-field experiences, I should say that nine times out of ten the one first asked by a layman, old or young, relates to the sensations of a soldier when wounded. Even though the questioner has been maimed in a railway smash-up, or torn or fractured or bruised in some peaceful and therefore safe (?) occupation, the interest is the same, on the supposition, doubtless, that to be hurt by one of the engines of destruction in war is productive of unique sensations.

First of all, generalizations will not cover this intricate and expansive subject. An infantry soldier at Gaines's Mill, who was hit in the knee by a bullet and ultimately died of the wound, said that he thought he had run against a standing thistle; and the fact that he marched on, until his comrades drew his attention to blood flowing down his leg, indicates that he did not make too light of the first sensation. An officer, whose ankle was shattered by a bullet as he stood upon a pile of fence-rails to reconnoitre, thought that a rail had turned under his weight and sprained the joint. He felt only a slight burning sensation, although the wound proved a mortal one in the end. On the other hand, a strapping, coarse-grained fellow, whom I knew well, and often remarked making light of the very idea of pain and suffering, quickly collapsed under a wound that he survived. And well he might. He was hit by a section of mortar-shell weighing three or four pounds that cut edgewise through his thigh, bone and all. He happened to be resting with his thighs across a small log that served as a block to the jagged cleaver. I was looking into his face, about to speak to him, at the very moment the missile struck, and, despite his callous fiber and almost brutal stoicism, he winced as though he felt—exactly as a human being might be supposed to feel under such a blow—all "broken up" by the calamity.

Wounds that almost kill on the spot seem to be the least felt at the outset. Slight ones often produce enough disturbance to suggest the work of a dozen death-hurts. A spent missile that only raises a lump will make the victim feel as though an arsenal full of balls had struck him; and often soldiers with ghastly mor-

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ism, are Von Sybel, of Berlin, and Philip Schaff, of New York. And it should be added that the latter went with commendatory letters from eminent prelates of the Catholic Church in Europe and America. For the closing citation, see Canon Farrar, History of Interpretation, p. 432.

tal wounds insist that nothing serious is the matter, and act up to the idea until death or nervous exhaustion lays them low.

This much, however, may be said in a general way: When felt at all, bullets through the flesh usually produce a burning sensation more or less acute. When bones are broken, stinging accompanies the burning. When bones are hit but not broken, there is a numbing sensation in the whole region involved in the shock, followed very soon by severe and sometimes intense pain. When muscles and tendons are involved, there is a tugging sensation, sometimes very slight, and shell-wounds produce feelings similar to those by bullets, more or less exaggerated, according to the size of the missile and the degree of velocity. Bayonet-wounds I never saw except upon corpses—for I was not a hospital attendant—and as for cannon-balls, they do not, as a rule, leave anything behind to exhibit feelings.*

Again, a soldier may receive two or even more hits so close together as to produce counter-sensations. I once saw my commanding officer prostrated by a piece of shell that shattered his thigh-bone. While he was falling, pieces of another shell hit him in the arm and hand, and a piece of a third shell quickly following grazed the crown of his head. He has always believed that he felt three ways at once during those few seconds, and he is very positive that he felt badly hurt, and cordially wished to be out of it.

Not infrequently, too, when a victim has been spared the smallest amount of vitality after the impulse of anger is cut short by a slashing wound, he feels very much as did an enthusiastic tar upon a trying occasion. In an affair now memorable in history, a certain war-vessel's crew was compelled by the etiquette of the service to stand by and see their country's flag hauled down in contempt, without being given a chance to strike in its defense. "It was the saddest hour of my whole life," said one of them, "and for quite a spell I alternated between a desire either to cry like a baby or swear like a pirate."

All this preliminary to a paper the scope of which is only partially suggested by the title. Poets and orators, who take a wholly sentimental point of view, ask the world to accept the notion that it is a glorious fortune for the individual man to suffer punishment in honorable warfare; but between the wound and the sequence, whether death or the hospital and the scalpel,

* Experts affirm that a cannon-ball having velocity to keep it in the air will make a clean cut of flesh, bones, and ligaments, and not simply tear them, or push them aside as with a punch; and that a ball slowing up and rolling along the ground at the rate at which a man moves in rapid walking will crush the bones of a foot or leg that resists it. In the civil war spherical and elongated shells usually served the stead of solid cannon-balls.

what are the symptoms, what the actions, above all, what the conscious feelings of the victim himself, or, as poetical fancy insists he shall be named, the hero? How wide or how narrow to his vision is the interval between the hard reality and the sentimental ideal? Flesh and bone of themselves can not be expected to rise to the height of the strained occasion. Torn and broken, glory never heals the one or sets the other; and so men's bodies will not forever remain insensible to the claims of Nature, even though in the excitement of war the mind may be superior to every consideration less than heroic. Yes, there must be a time when the will of the soldier is at odds with the forces that normally rule the sinews and tendons of his frame—a time, dear poet, when the hero proves to be only a man—a creature inspired after the flesh as well as after the spirit.

And now, looking at the soldier as a warring machine, does a missile fired into the delicate apparatus bring the whole engine quickly to a dead halt? The world hears so much about the Light Brigade at Balaklava that it should be familiar with the tragic story of the most noted victim of that affair, Captain Nolan. Nolan, as aide-de-camp of the division general, assumed to guide the Light Brigade in its awful charge, and, with frantic exclamation and vehement gestures with his uplifted sword, he rode to the right oblique beyond the head of the reckless column, in order to draw the six hundred out of the valley of death, which lay directly in their course, off toward a line of flanking redoubts which they had been ordered to attack, and where victory and not disaster doubtless awaited them. When he was a few paces to the right of the leading ranks a piece of shell struck him on the chest, tearing into the heart.

"The sword dropped from his hand," says the minute chronicle of Kinglake, "but the arm with which he was waving it the moment before still remained high uplifted in the air, and the grip of the practiced horseman, remaining as yet unrelaxed, still held him firm in his saddle. Missing the perfect hand of his master, and finding the accustomed governance now succeeded by the dangling reins, the horse all at once wheeled about and began to gallop back upon the front of the advancing brigade. Then, from what had been Nolan—and his form was still erect in the saddle, his sword-arm still high in the air—there burst forth a cry so strange and appalling that the hearer who rode nearest him called it unearthly. And in truth, I imagine," continues the historian, "the sound resulted from no human will, but rather from those spasmodic forces which may act upon the bodily frame when life as a power has ceased. The firm-seated rider, with arm uplifted and stiff, could hardly be ranked with the living. The shriek men heard rending the air was scarce other than the shriek of a corpse. The dead horseman rode on till he passed through the interval of the Twelfth Light Dragoons. Then at last he dropped out of the saddle."

The line between Nolan living and Nolan dead was very narrow, yet the uplifted arm* and the battle-shout ending in an unearthly yell would indicate that the soul of the warrior dominated every element of activity so long as any activity remained. Had Nolan been trotting along in the ranks of the six hundred with no other thought than that of keeping in line and getting ahead, he would doubtless have gone to the ground like a bolt under that blow.

An experience of the same nature, but at the other extreme, was that of General Joseph Hooker at Antietam. On the morning of the 17th of September, being in the presence of the enemy with his corps, he began a movement to seize high ground on his front, and was compelled to pass lengthwise of the Confederate line within range of hostile batteries. Soon a strong body of the enemy showed itself in his pathway, and in the excitement of making new dispositions, and routing and pursuing the Confederates, the general, to use his own language, "was lifted to the skies." "The whole morning has been one of unusual animation with me," he wrote also. Yet at the end of the successful attack he was removed from his saddle just as he was in the act of falling from it, weakened by the loss of blood from a wound of which he had not been conscious at all. A musket-ball had passed directly through the foot between the arch and the muscles of the sole, the seat, as every one knows, of very sensitive nerves. Had the general been in a state of moderate repose, as, for instance, quietly watching the execution of some movement, the blow would have unmanned him, for the moment at least. Intensely preoccupied as he was—and he had good reason to be, at that stage of the battle—he did not notice the blow or the sensations that accompanied and followed it. He may have carried the wound an hour or more before succumbing to the faintness.

My attention was first drawn to this subject by a strange personal experience—suspended animation in the body combined with partial mental clearness. The facts were of a kind that could be recorded with accuracy, and I am able to state them in detail. We were in front of the enemy at Fredericksburg Heights, May 3, 1863, and were lying under the shelter of a low ridge, expecting to charge or to repel a charge. The term of service of our regiment would expire the day following, and the troops

* External pressure—the weight of the sword and the pulling of the horse at the bit—would cause relaxation of grip in both sword and bridle hand, and collapse of the chest-walls the strange expiratory cry.

be sent home to disband, and with others I speculated not a little on the chances of escape in the impending fight. There had been times in my career as a soldier when I was "too anxious for wounds and scars," as General Grant once remarked of Ned Buntline, and even at the eleventh hour, with the prospect, as I believed, of a speedy return home, I consoled myself with the thought that if wounded I would carry a glorious badge on the homeward march. But I went into action that day, convinced on the whole, that the fellows across the line would not pay special attention to me, for I held that I was an indifferent mark for good ammunition—a lad of seventeen years, small inches, and light weight.

It turned out that our position, though supposed to be well sheltered, was closely inspected by a number of Confederate sharpshooters, but, as it was very important that we remain at that point, we had to make the best of it. I was near the head of the line of the regiment, and, as we lay strung along on the slope of the ridge, I could see every man in the command. One after another the sharpshooters' bullets began to tell. I noticed a lieutenant in one of the companies moving about on some official errand and making a splendid target, and, while I was thinking how cool he was, something struck him and twisted his body around so that I detected the break in his locomotion. He did not halt, but went on calmly and freely for some paces, and in a few minutes, having delivered some orders and exchanged words with some of his men, he went to the rear with a decided limp. Between the moment of his wounding and the accomplishment of his purpose he did not limp at all, and probably did not know that he was hit (it was a flesh-wound in the thigh) until told of it. Then, when he knew what had happened, he yielded to new mental processes and acted as wounded men are supposed to do. When the lieutenant had disappeared from view, I turned my face to the front, bolstering my trembling hopes with the thought that this last victim was a shining mark, as I certainly was not. Besides, I believed that the sharpshooters could not get the range on our end of the line. Then followed a "thud" close to me, and my next sensation was that I was prostrate on the ground, pierced through my left arm, heart, and spine with a rod, and pinned to the earth. This was the physical sensation, but, of course, was not the fact. Then through my brain there flitted quickly a vision such as the thought of a battle most commonly brings to mind—masses of warring men struggling individually for the mastery. I seemed to be in the midst of the *mêlée*, and with all the indignation I could express was shouting to the men in gray, "There, you have hit me!" Next I was being lifted and supported by some one, and a voice said, "He isn't hit, but something is the matter." "Yes," said another voice sternly, "he is hit, and as good as dead. Take him to the rear." I had so far recovered as to comprehend these remarks, and instantly concluded that I was the subject of a practical joke. In another moment I was seized with the keenest pain I have ever experienced in my life, in the region where it had seemed in my swoon that I was run through with a rod. Now, what had happened was this: I had been in a sitting posture, resting partly on the ground, partly upon my legs doubled beneath me, the left hand holding my weapon, the arm well braced across my chest so that the middle of the upper bone pressed against the heart. On my arm were two shirt sleeves, a jacket sleeve, an overcoat sleeve, and the overcoat cape; and a musket-ball moving in the direction of my heart and spine—that is, obliquely to the front of my person—had ticked the limb of a bush a few feet away, keeled over, and struck flatwise on the arm, imbedding itself in the flannel and the flesh. The bone, protected by the clothing, had been the resistant, and the shock, carried to the heart and spine, had rendered my body senseless for a time; but the brain, depleted by the sudden stoppage of circulation, had been abnormally active. The man who exclaimed that I was as good as dead had reason to think so. He was on the slope above, and was looking at me at the time. He heard the bullet, and saw me go down under it "like an ox hit on the head with an axe," as he expressed it. He also said that my face changed colors rapidly from ghastly white to deep purple, and that I lay on the ground so still that he believed for the moment that I was dead. It is evident that the fancies of the brain immediately following the wound were closely connected with the previous thoughts, for the burden of them was surprise and disappointment that, after all, I had been hit. It was somewhat singular that in my delirium I located my hurt correctly, and had the physical sensation of being pinned to the earth by a rod running through the very spot where the shock of the blow was keenest.*

An experience, similar in many respects, befell one of my companions in arms, Captain W. R. Helms, (Fourteenth New York Heavy Artillery, and Sixteenth New York Volunteers) at the battle of Gaines's Mill. Helms was a lieutenant at the time, and while the regiment was charging to recapture a battery that the Confederates had just taken and were about to open upon its late owners he was hit and went down. He heard his captain give the command, "Take his body to the rear," and saw men leave the ranks

* Statistics on this point have not been widely gathered, but numerous instances have been noted where severely wounded men who retained consciousness did not know the location of the hurt until sight or touch revealed it. Physiology accounts for the phenomenon in many ways. In my case an unusual area of skin and bone surface received pressure and the sensations were unusually strong.

to respond. He thought that his head only was lifted from the ground, and tried to speak, but could not. He recognized a fellow-officer who passed at the moment, and remarked upon the accident. Then he concluded that the battery had been fired, and that his head had been shot off. This puzzled him, and he began to speculate upon the phenomenon of a head carrying on reasoning processes while separated from the body. Was it not a mistake, after all, to believe that the soul is located in the body? Was not the experience he was passing through proof that the seat of all consciousness, will, and reason, and every spiritual attribute was in the head? (Helms was orthodox, and a remark from a skeptical physician, some time before, to the effect that dissection revealed no such an organ as the soul, had left a strong impression upon his young mind. He was yet in his teens.) Metaphysical thoughts were at length interrupted by a pricking and stinging sensation in the neck, and gradually full consciousness and motor power returned. He had been lifted and carried out of the reach of balls, head and all intact. A bullet had hit the leather straps of his haversack and canteen where they crossed his shoulders, cutting two and stopping at the third, as they lay close to the neck. (The flying ends of the severed straps caught his eye the moment it was done.) The collar-bone was broken, and the large muscles and tendons of the neck were badly bruised. Evidently there was temporary paralysis caused by injury of certain nerves at the neck, with but slight derangement of the functions of the organs in the head, while the sensory functions of the body were cut off from participation in sensations registered at the brain.*

In contrast with Captain Helms's counterfeit is a case of actual decapitation, noted vividly and vividly recalled by comrades of my regiment, particularly by one who was a careful and sensitive observer, Captain A. H. De Graff, now an engineering expert. On the 17th of June, in the charge of the Ninth Corps on the Confederate works east of Petersburg, a sergeant of the Fifty-seventh Massachusetts leaped upon the parapet, and, with his cap in his left hand and his musket in his right, stood cheering and gesturing with his arms to incite his comrades to come on. Suddenly a shell took his head off as completely as a knife could have done, but the tall form continued erect for some seconds, the arms still waving frantically, but with ever-lessening sweep and power, until the forces of the body collapsed, when the headless trunk toppled over to the ground.†

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* Physiology assumes that complete separation may take place at the neck and the functions of the divided parts go on for a space. A head freshly guillotined gave back mocking gestures of the mouth and eyes when a bystander made faces at it.

† A swift bullet will pass through a pane of glass and not jar it enough to crack it. The shell did its work without upsetting the body by the force of the blow. Dr. S. G.

Virtual subordination of the physical or material senses to the nervous centers controlling the intellectual or spiritual faculties, and for an appreciable length of time, seems to be quite common in wounded men, even in the severest cases. It is easily conceivable that a thoroughly mad man might ignore an ordinary wound until his anger cooled a little; but that men wounded to the death should, even while actually dying, persist in their purposes as though nothing had happened, at first staggers belief. Yet such things do unquestionably occur. Every veteran of the field will recall instances, and history in one way or another records a great many. In the attack on the Ninth Corps lines at Petersburg, known as the battle of Fort Steadman, I noticed a mounted Confederate officer leading a body of men in a charge upon a cannon near which I stood. The last view I had of him—and that was across the sight of a Springfield rifle—showed him riding boldly forward, sword on high. Others saw him later and nearer, and his fearless action in riding a white horse under a storm of bullets, grape, and shells attracted much notice. Suddenly man and horse disappeared, and after the fight we found the bold rider lying dead about sixty to eighty yards from our parapet.* His form was prostrate, his sword-arm outstretched and grasping the weapon firmly, with its point toward the cannon he had aimed to capture. His face was partially upturned, as though he had struggled at the very last to see something or to speak. The horse had wheeled about and gone to the rear some distance, then had leaped at a breastwork and fallen dead across it. Whether this was after his rider had been hit or before couldn't be determined. In any case the Georgia major breathed his last with his face to the foe, evidently warlike and defiant in death. His wound was in the head.

An instance similar to the last was that of General Elon J. Farnsworth, at Gettysburg. At a crisis in a charge, Farnsworth raised his saber and rode toward the ranks of the Fifteenth

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Cook, now President of the Board of Police Surgeons in New York city, witnessed a similar instance in the Atlanta campaign, where he served as surgeon in the One Hundred and Fiftieth New York Volunteers. The doctor, with other officers of the medical corps, was riding rapidly across the range of a Confederate battery, which was shelling a column on the march. Hearing a "thud" behind, as a shell passed near him, he turned around and to his amazement saw that one of his companions, Surgeon H. S. Potter, of the One Hundred and Fifth Illinois, had been decapitated, and his horse was galloping on with a headless rider sitting perfectly erect and natural in the saddle. With a little steadying the body remained upright until shelter was reached, the pace being all the while a gallop.

* From conversation with the late Henry W. Grady, respecting his father, who lost his life in this attack, I believe this officer to have been Major Grady, of Georgia. I did not shoot him. After drawing bead on him perhaps half a dozen times, admiration for his unexampled daring got the better of me, and I lowered the weapon with the exclamation, "He is too brave—I can't do it."

Alabama Infantry, meeting a volley of balls. Shortly afterward his riderless horse dashed through the regimental lines. The general had fallen, with five mortal wounds, and when found still clutched his outstretched saber, and bore the appearance of having been unhorsed when dead or dying, much as in the case of Captain Nolan.

In the excitement of such actions as those where the Georgia major and Farnsworth fell, it is not possible for any observer to note the symptoms minutely. The fact that a man is down and out of the fight is about all that friend or foe can take account of for the time being. It is reasonable to suppose, however, that some deaths are instantaneous, the men being literally killed in action. One such case I had an opportunity to study with unusual care at Fort Haskell, in the Fort Steadman battle at Petersburg. The action there was defensive on our part, the scene very small, and the fight prolonged, hence many things were observed that would escape notice on an open field. At one time, just in front of me as I looked toward the enemy, there was a soldier of our garrison firing his musket from a gun-staging that raised his head and shoulders above the parapet. He was the oldest man I ever saw in battle, and for that reason doubtless I observed him closely. His hair was white, and his form had reached the stage of unsteadiness. He fired very slowly, and after each shot would scan the enemy's lines, as though watching the results of his last ball or spying out a target for the next. Finally, when I had my attention almost wholly on him, he half turned to reload, and I saw his cap fly off smartly without any visible help, and the large and bony frame shrink together and sink down into a heap. There was no spasm, no agitation whatever. It seemed to me that he simply sat down slowly until he rested on his legs, bent under the body, his head going down to his knee, or to the trail of the cannon. A little stream of blood ran from his forehead and made a pool on the plank, and this blood reached the plank about the time that his frame settled itself down motionless. From the time that his cap flew off until the blood appeared on the staging, and the motionless body led me to say, "He is dead," could not have been more than thirty seconds, and was probably about twenty. The fatal ball had penetrated the left temple or near it. This was the only case where I noted all the external manifestations of a soldier killed "so quickly that he never knew what hit him," as the saying is.

All that are found dead on the battle-field figure in the lists as "killed in action." Of these quite a percentage may meet with instantaneous death, but the majority show proof that both body and mind were at work after the fatal blow was received. One of the most convincing cases of the kind, and at the same time the most terrible, that came to my personal knowledge was at Antietam, where General Hooker conducted the fight when he received his wound. The Confederates were massed in a field of tall corn, and Hooker ordered his batteries to open on them with canister. In his report he says that the shot cut every stalk of corn in the greater part of the field close to the ground as neatly as though done with a knife. Of course, the men in that field did not escape the biting hail. Neither did they stand like lambs and accept their doom. After the first cannon volley the survivors started toward Hooker's batteries, mounting a rail fence that barred their progress, and just in front of and along this fence several hundred lay dead after the action. The regiment in which I served took position at one end of the fence some hours afterward, and as this field was between the lines the bodies had not been disturbed. About sundown there was a sort of truce to remove some of the wounded, and with others I passed along the fence to see the line of the dead. Some of the poor fellows had passed over the fence and begun creeping forward, gun in hand; some had gained the top of the fence, and death had left them balancing across the rails; others, in the act of climbing, had died leaning against it or dangling from it head foremost, having passed partly over and been caught by the feet. Generally the sword or musket was held in firm grip, the eyeballs turned forward, and every muscle and organ bearing evidence of having been strained to get at the batteries that were making such dreadful havoc. When I returned to the end of the line and glanced back again at the prostrate column, I said to my comrades who had not gone out to get a close view: "Boys, it is just as it looks from here. Those men were caught at it, and were struck down in the act." It is not to be wondered at that General Hooker was too much absorbed at the time of this fighting to notice his wound. He wrote of the action that the "slain (Confederate) lay in rows precisely as they had stood in the ranks a few moments before." *

Very, very few of these dead bore the look of having passed away composedly. Yet, on the ordinary battle-field, where the killed outright number but two or three to every hundred of combatants, the exceptions are those who do not die in a quiet state of mind or body. Men who are cut down in a charge, while the tide of heated action sweeps on, leaving them alone, bend their thoughts at once to themselves, and, if death is felt approaching, turn their faces up to the quiet skies, compose their

* The scene here described was visible from two o'clock P. M. until sundown from the northern edge of the East Wood along the fence running from the East Wood westerly to the Sharpsburg pike, and separating a corn-field from the elevated cleared field lying south of the Miller farmstead.

souls, and so breathe their last. It will be only in some such struggle as at Antietam, or before the stone wall at Fredericksburg, or in Pickett's charge at Gettysburg, and the front line at that, that men will die retaining full intensity of battle ardor so long as breath holds out. There we may expect to find men dead with their weapons poised and their colors held firm in the death-grip.*

The manner in which men fall depends also upon the nature of the action in which they are engaged. Nearly every one is familiar with the traditional stage fall, where the victim of a supposed death-shot strikes an attitude, clasps his hand to his heart, stiffens every joint and muscle, breathes hysterically, and goes down like a log toppled over from the end. Another popular yet erroneous notion is that men shot through the vitals leap into the air and go down in a dramatic attitude. Sometimes men are found on the field in striking positions, but often an examination shows that the position was taken after the fall. As a rule, a man who is hit above the hips goes down.† The slighter the wound the more commotion, for the body instinctively resists, just as it does when one slips or is pushed or collides with some object. But a wound in a vital spot weakens the resistance, and men sink at once, or reel and tumble with very little self-control. One reason why men are found dead in a variety of positions is that so long as consciousness remains they strive to help themselves. The wound and the fall together create a temporary panic. Any one who knows the sensation of being temporarily arrested, when at a high rate of speed, by some accident, may imagine the general state of mind of a soldier when hit in action. Something has happened; he is the victim; how serious is it? A man's first thought is of the rear of the column, and this not from fear, but because he expects surgical aid from that direction. So long as he can move he goes toward the place of help. When no longer able to move he makes himself as comfortable as he can and waits. In this waiting many die, and it is a question whether many do not die from over-anxiety—that is, add to their hurt by fretting and struggling. There are soldiers of the civil war living to-day who received wounds as serious at the time as some who died on the field. Either their temperaments were more hopeful or their circumstances more favorable.

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* Physiological science recognizes, and in a measure accounts for, *rigor mortis* in cases of the kind cited.

† There is an apparent, but, I think, not a real contradiction of this statement in the statistics collected by Dr. S. Weir Mitchell, in the United States Army Hospital at Philadelphia, during the war. Out of fifty-six wounds involving the arm system of nerves, twenty-seven fell. But he had excluded all cases accompanied by "early and severe hæmorrhage," and was not considering the dead and mortally wounded, nor those cases too severe for long-distance transportation.

Returning to the question of persistent aggressiveness in severely wounded men, two instances remarkable in a special way are worthy of note. There was no warlike anger, but simply sudden excitement, for a cause. In one instance two soldiers were practicing at bayonet exercise and became very much warmed up, as men do in a boxing match. Finally, when one of them made a lunge at the breast of the other, the muzzle was knocked down slightly by the opposing piece and a discharge followed, the bullet going through the groin. With this frightful wound, given at a couple of feet at most, the unfortunate victim kept a tight grip on his piece, staggered forward, and made fitful lunges at his opponent, who dropped his gun and ran, terrified by the unearthly stare and grimace and the frenzied actions of the other. It was supposed that the balls had been drawn, and the man whose piece went off did not know at once that the charge was fatal. The injured man gave chase for a few paces and then fell dead.* A case where there was even less external incitement to extraordinary endurance is recorded by Captain J. F. J. Caldwell, in a history of Gregg and McGowan's South Carolina Brigade. During the engagement at Sutherland's Station, below Petersburg, April 22, 1865, Captain Caldwell, while riding over the field on staff duty, met two Union soldiers who had broken through the Confederate lines with a charging column that had been repulsed, and become separated from their comrades. Resistance was useless, and they dropped their guns and followed the captain toward the Confederate rear. One of the prisoners lagged on the march, and, on being told to step lively, he held up one arm and showed such a bloody and distressing wound that the captain allowed him his own gait. All the time both prisoners chatted briskly about the Union tactics, and boasted that the tables would soon be turned upon the Confederates. When the party came to a fence the wounded man helped to let down rails for the captain's horse, and in every way showed good spirits and fair condition. At the first medical bivouac Captain Caldwell turned his charge over to a surgeon, who found a second wound in the patient's breast, and in a few minutes after halting death ended his captivity. The man had borne up under a mortal wound, with the spur of personal enthusiasm and expectation. He had hoped for a recapture by the advance of the Union lines.

The conduct of wounded men after an interval I do not purpose to describe. So soon as the mind gets settled down to the

* Paré, the French surgeon, recorded the case of a duelist who received a sword-thrust through the heart, large enough to admit a finger, and who followed up his fleeing antagonist, thrusting repeatedly, for two hundred yards before he fell.

new order of things, individual temperament resumes entire control. The phenomena of severely wounded soldiers continuing in action is correctly ascribed to abnormal mental excitement. Analogies are seen in every-day life. Contusions, incisions, and even fractures are sustained during excitement and no immediate impression is carried to the intellect. Yet how keen the suffering experienced under slighter hurts made by the surgeon's scalpel, forceps, or drill, when all is known beforehand! A soldier's life predisposes to intensity in either direction. He will stoically ignore or morbidly welcome injury. His mind, first of all, is made up not to notice danger or to be unmanned by wounds. So long as he can keep in action—that is, so long as he may personally direct some expenditure of muscular energy—his stoical purpose will hold out. As a matter of course, when he changes from a personality to a mere machine, manipulated by higher minds, fighting when told to, and again standing or lying still to receive blows and injuries with no chance to retaliate, he changes from a Stoic to a morbidly sensitive being. Familiar with deep and distressing injuries to others, in hugging the hope that he will be spared the worst, he invites fears for the worst at the moment he receives a blow, and fears strike the mind as soon as the bullet hits the body. This may account for frequent aberrations of conduct that follow ordinary wounds. The bravest may be unmanned by them, and doubtless death-fright actually takes place with gallant souls; or, if neither death nor delirium follow, then extravagant notions of pain, and violent wailing over trifles.

Numberless cases might be cited showing that excellent soldiers are thrown into sudden mental and physical panic by war wounds, just as civilians are by injuries and surgical operations. Exaggerated sensations of suffering and often quick delirium are reported from the battle-field, such as can not be the direct and necessary sequence of the actual injury, but take rise in the emotions.

As a rule, reported war cases are confined almost wholly to injuries not necessarily fatal. Fatal ones rarely get on record, because the cool and observant surgeon does not study the symptoms of the actual field of fighting.* Of those who are struck insensible and subsequently revive and survive, there are known to be many; but of the number rendered insensible who revive and resume action and then die, there can only be conjecture. In this class must be placed many whose attitudes in death are abnormal. But taking into account the symptoms of the wounded who have lived to report them, and of the dead whose cases have

* In the civil war the proportion of deaths to the surviving injured was a trifle more than one to three.

been recorded by spectators, there is a general agreement that symptoms do not at all correspond in kind or severity to the injury.* Hence phenomena appearing at first thought remarkable may be accepted as not uncommon, considering the unrecorded instances.

I class as remarkable the cases of Nolan, Hooker, Farnsworth, the Georgia major, the beheaded sergeant, the wounded prisoner, and the man skylarking in bayonet practice, and will add that of General Albert Sidney Johnston, killed at Shiloh; and it is proper to state that this collection sprang originally from an effort to bring together the same order of phenomena without reference to antecedent causes. Further investigation proved that, of these cases, Nolan, Hooker, Farnsworth, the Georgia major, and Johnston certainly, and presumably the Massachusetts sergeant, had the highest order of emotional stimulation at work before closing into the heat of action.

It was Nolan's first chance in real war. He had served on routine headquarters duty until that day, and being sent to the front in a crisis, he galloped his horse down a rocky steep where no hoof had ever before trodden. On delivering an order to the division commander, words ensued as to its meaning, and Nolan's excitement was increased. When at last the Light Brigade started and went wrong, he kept the intended course alone, saying, with all the powers of voice and gesture he could command: "This way, this way! For Heaven's sake, not that way!" While so engaged he was hit in the most vital spot in the body, yet warlike action was persistent to an almost supranatural extent.

Hooker had just received command of a corps; there was rivalry between him and others; he was honored with the lead in the most important attack; the enemy's resistance was unexpectedly stubborn, the carnage frightful above all experience on any American battle-field, and on him rested the responsibility of success that would glorify the whole army and the nation.

Farnsworth, on being asked to lead a cavalry charge over a field strewed with bowlders and swept with cannon, demurred, and his chief said to him tauntingly, "If you will not lead your brigade in, I will." "Where my brigade goes, I will lead," was the answer, and he sounded the charge. He found a slaughter-pen as he had expected, was hemmed in, and with fifty followers started to cut his way through a double line of Confederate infantry.

* The small missiles which inflict the majority of war wounds strike fewer nerves of pain than do the instruments of injury in ordinary collisions, where large areas of skin surface are bruised or lacerated; their execution is also more rapid. The instantaneous collapse following violent symptoms of warlike vigor is also a peculiarity of battle-field life. Violent mental and muscular actions have swiftly depleted the reserve forces, and, where collapse would be slow under normal strains, it is swift in abnormal cases.

Possibly his five mortal hurts were received simultaneously, but probably he carried two or three of them while persisting in his fight.

The Georgia major had been selected or had volunteered to lead a forlorn hope upon which the salvation of an enterprise depended, and he was called upon to pass eighty rods under cross-fire of cannon and muskets. That feat he essayed, conspicuously mounted upon a white horse.

The attack in which the Massachusetts sergeant engaged was the third day of fierce and progressive onslaughts, and was directed against the last but one of Lee's interior lines around Petersburg. The stubbornness of the Confederate resistance had aroused the spirits of the assailants to the supremest pitch.

General A. S. Johnston at Shiloh was engaged in a campaign for the recovery of territory valuable to the Confederacy; he had been transferred from the East to supersede other generals; his fame was at stake; he had engaged upon one of the most daring and delicate enterprises known in warfare, a surprise of his enemy, to end in a wholesale slaughter or capture of the routed hosts on the banks of a bridgeless river. The movement carried well up to a point; there, a Union division showed what Johnston pronounced stubbornness; his men hesitated, and he went personally with one brigade in a charge; the charge succeeded, and he drew back to bring up another brigade, when a musket-ball severed an artery in his leg. He made no sign, but kept on giving orders and watching events until spectators saw that he was pale. He was asked if he was wounded, and, as if acknowledging it to himself for the first time, said: "Yes! And I fear seriously." He was then on the point of death from hæmorrhage.

Under normal conditions the symptoms in each of the cases in this recapitulation, except that of the headless man, should have been trembling, tottering, pallor, faintness, nausea, with expression of anxiety and distress, the whole frame being instinctively sympathetic with the injured part. But the several nerve-centers were not in a condition to perform normal functions. The mental excitement acting in the nature of a stimulant upon the center of the brain, monopolized the capacity for keen sensation, and centers that should have registered the hurt suspended their functions. So there was no concentrated shock, as ordinarily happens. The shock was distributed and showed itself, when finally potent, in an instantaneous collapse. This is the theory generally accepted by science—the theory of a law that two nerve-centers can not be excited at one and the same time. Is there not confirmation of it in the complicated case of the wounded prisoner reported by Captain Caldwell? The man doubtless suffered laceration in the arm and the cutting of an internal artery, by the same ball in the order named. His arm-wound would register its shock first upon the intellect, and it would be of a kind that a soldier in his situation would speedily resolve to "grin and bear"; and the second, though mortal, would be overlooked, and suffered to do its quiet and fatal work. His first wound increased the existing excitement at the chief nerve-center, and aided to suspend the functions of the center most vitally involved in the wounding. The case of the beheaded man is again anomalous. Spasmodic action or discharge of the motor-forces stored in the nerve-centers of the trunk may have produced the phenomena.

Incidentally there arise from the consideration of the foregoing these two questions: First, could the expenditure of stored-up nerve force, either in sound or injured parts, or in both combined, generate all these erratic manifestations, or do impulses issue direct from the brain so long as life holds out? Second, is there a battle frenzy peculiar to certain natures, and in certain conditions to average men as well, that may lend them abnormal powers of nervous vigor and endurance? But, whatever the efficient cause, at least one compensating thought follows a study of these phenomena, and the poet and orator may extract some comfort from it, cold and speculative though it may appear. The soldier in war bears up under a severer hurt than the same man could endure in every-day life, and collapses under a lesser one than would ordinarily be required to disable him. He bears up longer and collapses more quickly. Therefore, the provision of Nature that renders him insensible of wounds in heated action may be a twofold blessing, in that it spares him pain and terror at the moment of his hurt, and while doing this service rapidly exhausts in his system those reserve forces which might otherwise tide him over the inevitable prostration succeeding wounds and warlike ardor, and embitter him with a sense of his vulnerability and weakness. How many noble fellows, missing the lethal stroke, have besought their comrades, their captors, and their medical officers to put them out of misery, annalists of the field would shudder to make known. So the hero's impulse, be it patriotism, fanaticism, or frenzy, in spurring him on, saves his high-strung soul from the rack of physical torture, and brings death in a moment of rapturous exaltation, weaving about his last deeds the halo of that glory which is the soldier's most coveted reward. Not alone soldiers, but men of action everywhere, long for a death that shall be but a pause—no, that could be perceptible—a lightning leap between a fiery fullness of being on earth and the dazzling dawn of new life beyond the veil.

THE YUCCA MOTH AND YUCCA POLLINATION.*

By C. V. RILEY, Ph. D.

THE common belief, based upon the theological assumption that all things upon this terrestrial sphere are for man's especial benefit, was, and perhaps yet is, that flowers were endowed with beauty and fragrance for our particular pleasure. Let us look somewhat more closely into this matter, and see what modern science has to say about it. Ever since Linnæus used the sexual characteristics of flowers in classification, and Erasmus Darwin sang of the loves of the plants, the philosophy of fertilization in the plant kingdom has been fairly apprehended. It has long been recognized that plants are divisible into homomorphic or self-fertilizable, and heteromorphic or cross-fertilizable species. All diclinous plants, or those having separate male and female flowers, belong to the latter category, which is further classifiable according to the means by which cross-fertilization is effected. One class (termed *anemophilæ*) depend almost entirely on the wind, and in these, of which our pines and other conifers, our poplars, willows, grasses, etc., are examples, the pollen or male element obtains in enormous quantities, is easily detached, and is generally produced early in spring, when winds prevail, and frequently before the development of the leaves, which would tend to impede its dispersion. The flower is inconspicuous and the stigma or female organ generally branched or hairy, so as to increase the chance of catching the wind-borne pollen. Water is an agency in the fertilization of a few plants, of which the singular Vallisneria is a striking illustration; while a few are aided by birds and higher animals; but by far the greater number are fertilized, or, more strictly speaking, pollinized, by insects.

The most casual observer of Nature must have appreciated, years ago, the fact that flowers are very important to insects, furnishing the essentials of life to those of several orders, and especially to the Hymenoptera (bees, wasps, etc.) and Lepidoptera (butterflies and moths) in the form either of pollen or nectar. But that insects could be of any especial benefit to plants has only come to be acknowledged and fully appreciated of late years. Toward the close of the last century Christian Konrad Sprengel published an important work—Das entdeckte Geheimniss der Natur—in which he maintained that the color, form, odor, secretions, and the general structure of flowers had reference to insects which are essential as pollinizers. The importance of insects as

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* Adapted from advance sheets of the Annual Report of the Missouri Botanical Garden for 1891.

agents in cross-fertilization was scarcely appreciated, however, until the late Charles Darwin published the results of his researches on Primula, Linum, Lythrum, etc., and his elaborate work on the fertilization of orchids. The publication of these works gave to flowers a new significance and to their study almost as great an impulse as did his immortal Origin of Species to the general study of biology. Hooker, Bennett, Axell, Del-

Fig. 1.—Flower of Yucca aloifolia, showing stouter pistil and shorter style as compared with *filamentosa*.

pino, Hildebrand, Hermann Müller, and others abroad, and Dr. Gray and Prof. William Trelease in this country, have followed up this subject; and no one can familiarize himself with the results of their studies without a keen sense—if not a conviction—that in the vast number of cases Sprengel's early statement holds strictly true. By these deeper insights into the significances of the floral world, and their harmonies with the insect world, we learn to understand why night-blooming flowers are usually white, even where their day-blooming allies are brightly colored, as in the case of *Lychnis vespertina* and *L. diurna*; or why the calyx, which is usually hidden and green, becomes bright when exposed, as in the berberry and larkspur. Many flowers are known to close or "sleep," and while most of them follow the animal world in taking this rest at night, yet there are marked exceptions. The dandelion goes to rest at 5 P. M. and wakes at 7 A. M., while the popular names of "four o'clock" and "John-go-to-bed-at-noon" sufficiently indicate the sleeping hours of Mirabilis and Tragopogon. Sir John Lubbock tritely asks, "What is the meaning of sleep in flowers, if it is not in reference to insects?" The closing during those hours when the particular insects needed for pollination are at rest, would protect the flower from spoliation by useless raiders. This belief is also strengthened by the fact that anemophilous flowers, or those fertilized by the wind, never sleep, and that flowers which attract insects by smell emit their odor at particular hours.

But the most interesting fact not commonly understood, that has now been very fully established by the most thorough researches, is, that a very large number of plants, even where the sexes are united in the same flower, absolutely depend on insect aid for pollination, and that the contrivances to induce cross-fertilization are infinite in diversity, while the modifications in structure which these insects have undergone the better to fit them to perform this service, are equally remarkable. Yet in most cases we have adaptation of the plant only, and except in a few instances, as, for instance, in that Madagascar orchid, *Angræcum sesquipedale*, where the nectary is so deep that its nectar can be reached only by a moth (like *Macrosila cluentius*) with a very long tongue, our orchids are not dependent for pollination on any one Lepidopterous species, but may be aided by many which have tongues of sufficient length.

There are, in fact, few plants which are dependent on a single species for pollination. So far as I know, the yuccas furnish the only instance of this kind, for they actually depend on some particular species of little white moths belonging to the Tineina and to the genus Pronuba. The yuccas are a very interesting genus of lily-like plants, so familiar to every one in our public and private gardens that I need not say very much about them (Fig. 1). There are numerous species and even sub-genera, but they are all characterized by anthers not reaching anywhere near the stigma, so that fertilization unaided can take place only by the merest accident. In other words, the stigmatic tube is nowhere within reach of the stamens, and the pollen either remains attached to the open and withered anthers or falls and remains in different-sized lumps on the inside of the perianth, and can not be introduced into the stigmatic tube without artificial aid.

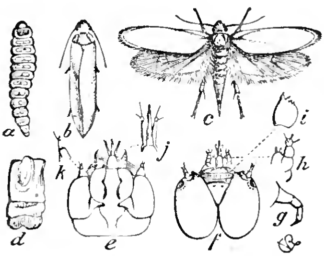


FIG. 2.—PRONUBA YUCCASELLA: *a*, larva; *b*, ♀ moth with closed wing; *c*, ♀ moth with wings expanded—natural size; *d*, side view of larval joint; *e*, head of larva, beneath; *f*, head of larva, above; *g*, thoracic leg of same; *h*, maxilla; *i*, mandible; *j*, spinneret and labial palpi; *k*, antenna—enlarged.

Our commoner garden yuccas, forms of *filamentosa*, depend on the commoner yucca moth, *Pronuba yuccasella* (Fig. 2, *b*, *c*), and so do all the different species found east of the Rocky Mountains, so far as we yet know. During the daytime we may, by knowing what and where to seek, often find this moth, either singly or in pairs, resting with folded wings within the half-closed flowers. It is then not only hidden from ordinary view, but well protected by the imitative color of the front wings with that of the flower, so that close scrutiny is necessary for its detection. If we visit the plant after

> ". . . the garish day
> Has sped on his wheels of light away,"

and when, with full-blown perianth, the yucca stands in all her queenly beauty, and sends forth her perfume more strongly upon the night air, we shall, with a little patience, meet with this same moth, flitting swiftly from flower to flower and from plant to plant—the dusky nature of the hind wings and of the under surface of the front wings almost completely offsetting and neutralizing, when in motion, the upper silvery whiteness of the latter, and thus still rendering the insect a little difficult of detection. It is principally the male which we thus see flying and, by the aid of a "bull's-eye," we shall find the female for the most part busily at work in the flowers. He, with relatively stronger wing-power, can afford to spend in the most pleasurable way the few brief days allotted to him; but *she* is charged with a double duty, and loses little time in its performance. As a part of the maternal task of continuing her race, she must act as foster-mother to the plant in order to insure a proper supply of food to her larvæ, which, as we shall presently see, feed on its seeds.

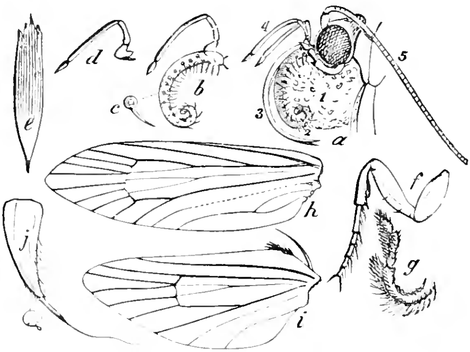


Fig. 3.—Generic Characters of Pronuba yuccasella: *a*, side-view of head and neck of female denuded, showing how the collected load of pollen (1) is held by the tentacles (2); *b*, maxillary tentacle and palpus; *c*, an enlarged spine; *d*, palpus separated; *e*, scale from front wing; *f*, front leg; *g*, labial palpus; *h*, *i*, front and hind wings denuded; *j*, anal joint of female with ovipositor—all enlarged.

As preliminary to a better understanding of the habits of the female, it will be well to draw attention to those structural peculiarities which distinguish her from all other species of her order, and which so admirably fit her for the work she has to do. Fig. 3 gives some details of the head (*a*), and an important structure which more particularly characterizes her and interests us is the maxillary tentacle, shown with its palpus at *b*. She has a pair of these organs, which are prehensile and spinous, and it is chiefly by means of these that she is able to collect and hold a relatively large load of pollen for the purpose of pollination. Another organ which is characteristic is the ovipositor (Fig. 4, *b*, *d*), which is delicate and extensile, being a combination of lance and saw, and admirably adapted for cleaving through the young fruit and then running the egg, which is long and filiform, into the ovarian cavity.

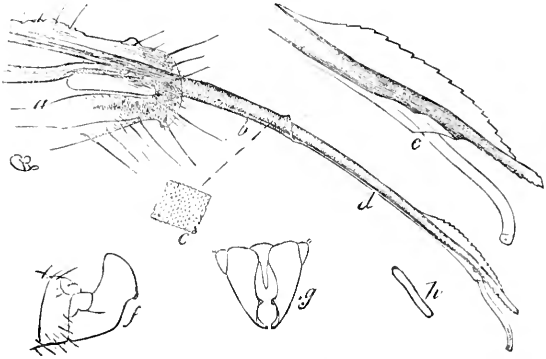


FIG. 4.—GENITAL CHARACTERS OF PRONUBA YUCCASELLA: *a*, tip of ♀ abdomen rendered somewhat transparent; *b*, basal joint of ovipositor; *c*, its sculpture; *d*, terminal joint of same; *e*, tip still more enlarged; *f*, genitalia ♂ from side; *g*, genitalia ♂ from above; *h*, undeveloped egg from ovary—enlarged.

Though all the acts of the female are nocturnal, it is not at all difficult to follow them with a lantern, for, albeit ordinarily shy, she may be closely approached when she is about to oviposit. Her activity begins soon after dark, but consists at first in assiduously collecting a load of pollen. She may be seen running up to the top of one of the stamens, and bending her head down over the anther, stretching the maxillary tentacles, so wonderfully modified for the purpose, to their fullest extent, the tongue uncoiled and reaching to the opposite side of the stamen (Fig. 6). In this manner she is able to obtain a firm hold of the same while the head is kept close to the anthers and moved peculiarly back and forth, something as in the motion of the head of a caterpillar when feeding. The maxillary palpi are used in this act very much as the ordinary mandibles are used in other insects, removing or scraping the pollen from the anthers toward the tentacles. After thus gathering the pollen, she raises her head and commences to shape it into a little mass or pellet by using her front legs very much as a cat does when cleansing her mouth, sometimes using only one leg, at another time both, smoothing and pressing the gathered pollen, the tentacles meanwhile stretching and curving. After collecting all the pollen from one anther, she proceeds to another and repeats the operation, then to a third and fourth, after which, with her relatively large load—often thrice as large as the head—held firmly against the neck and front trochanters, she usually runs about or flies to another plant: for I have often noticed that ovi-

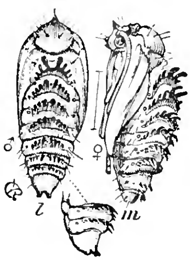


FIG. 5.—PRONUBA YUCCASELLA: *l*, male; *m*, female chrysalis—hair-line showing natural size.

position, as a rule, is accomplished in some other flower than that from which the pollen was gathered, and that cross-fertilization is thus secured.

Once fully equipped with this important commodity, she may be seen either crawling over or resting within the flower, generally with the head toward the base. From time to time she makes a sudden dart and deftly runs around the stamens, and anon takes a position with the body between and the legs straddling two of them, her head being usually turned toward the stigma. As the terminal halves of the stamens are always more or less recurved, she generally has to retreat between two of them until the tip of her abdomen can reach the pistil (Fig. 7). As soon as a favorable point is reached—generally just below the middle—she rests motionless for a short time, when the abdomen is slightly raised and the lance-like ovipositor is thrust into the soft tissue, held there the best part of a minute, while the egg is conducted to its destination, and then withdrawn by a series of up-and-down motions. Fig. 8 is a transverse section of the young fruit at this stage of the growth, indicating the manner in which it is punctured at *a, a,* and how the egg is conveyed into the ovarian cell at *b*, while Fig. 9 shows a longitudinal section of the pistil at *a*, the puncture of the ovipositor at *b*, and the egg within the ovarian cell at *c*.

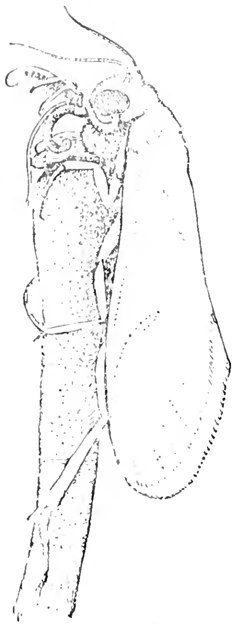


Fig. 6.—Pronuba yuccasella, female, in the act of gathering pollen from the anthers; five times enlarged.

The stigmatic liquor is not nectarian, and the flower secretes but a small amount of nectar at the base of the petals; and while these facts serve to disprove any positive value of their nectar in the pollination of the yucca flowers, they add to the importance of Pronuba by showing that the acts of collecting pollen and transferring it to the stigma do not result in any food compensation, as I was at first inclined to suppose. In other words, there is no nectar to allure other nectar-loving insects and cause them to go to the stigma; but, on the contrary, those which are drawn to the plant by the slight amount of nectar are led in the very opposite direction, viz., to the base of the style or of the flower. It is also an interesting fact that I have never noticed Pronuba feeding, as contradistinguished from pollinizing, for the motions of the tongue of Lepidoptera when feeding are quite characteristic and easily recognized. Indeed, the two pieces which form the tongue are so often separated at tip, and so weakly joined throughout, as to raise the question, in connection with a somewhat imperfect alimentary canal, as to whether the moth feeds at all, and to suggest that the rather strong tongue, otherwise, assists pollination.

No sooner is the ovipositor withdrawn into the abdomen than the moth runs up to the top of the pistil, thrusts the pollen into the stigmatic opening, and works her head rapidly—the motion

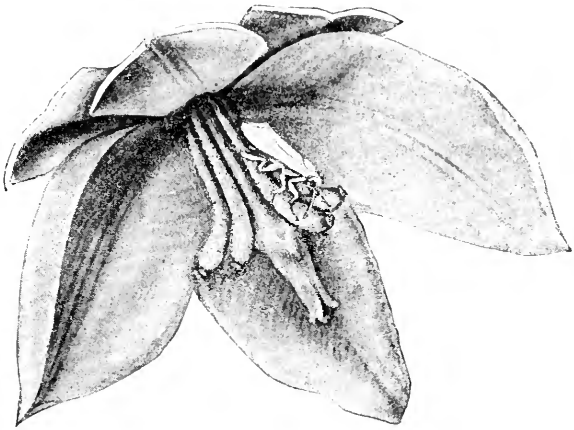


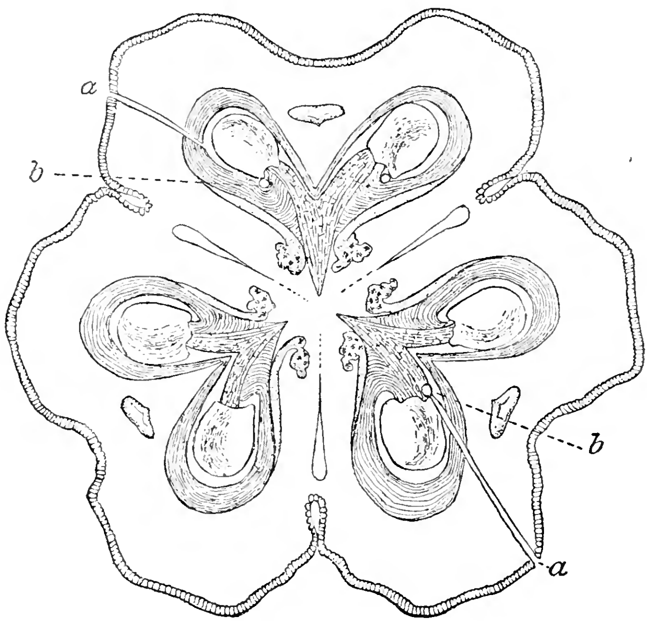
Fig. 7.—Flower of Yucca, with near petals removed to show normal position of Pronuba in ovipositing.

being mostly up and down and lasting several seconds. She works with a vigor that would indicate combined pleasure and purpose, and makes every effort to force the pollen into the tube, thrusting it ordinarily from the base of one of the three primary clefts of the style. After the more vigorous motions of thrusting the pollen into the tube, she frequently rests in comparative quiet, working her tongue in the tube sometimes for four or five minutes together, but ordinarily the act of pollination ceases with the few vigorous thrusts already described. The importance of this act will be better appreciated when I state that numerous experiments in artificial or brush pollination have shown that effective fertilization in *Yucca filamentosa* is by no means an easy matter, and that it rarely takes place as effectively as through the actions of Pronuba.

This carrying of the pollen to the stigma generally follows every act of oviposition, so that where ten or a dozen eggs are consigned to a single pistil, the stigma will be so many times bepollened.

The egg of Pronuba is an extremely delicate, thread-like structure, averaging 1·5 millimetre in length and less than 0·1 millimetre (Fig. 9, *c*) in diameter, tapering at the base and enlarging slightly toward the capitate end, which has also a slightly indurated point. It is impossible to follow it with the unaided eye, or in fact with an ordinary lens, even if the pistil be at once plucked and dissected; but, by means of careful microscopical sections, we may trace its course, as shown in Figs. 8 and 9.

The larva hatches in about a week and will be found at a point from eight to ten ovules above or below the external puncture, according as the egg was thrust above or below it. It has no pro-legs, but has well-developed thoracic legs. It matures with the ripening of the seeds, which differs in time in the different species of yucca, and also in the same species, but occupies on an average about a month in the ordinary *Yucca filamentosa*. The number of seeds destroyed is rarely more than a dozen and more frequently less, and I have recorded the fact of having found as



8.—Transverse Section of Pistil, about middle, one day after oviposition, showing (a, a) puncture of ovipositor, and (b, b) position of egg.

many as twenty-one larvæ in a single pod. Just about the time the pods are hardening and ready to dehisce and the seeds have already colored, the full-grown larva bores its way out of the pod and makes its way to the ground. It remains as a larva within its cocoon during the fall, winter, and spring months, and only transforms to the chrysalis state a few days before the blooming of the yuccas. The chrysalis (Fig. 4), as shown in the figure, is armed with an acute spine on the head and with singular spatulate spines on the back, which are well fitted to enable it to work its way to the surface from its underground retreat.

The effect of the puncture of the female moth in oviposition is at once noticeable on the young fruit by a darker green discoloration externally. In time this becomes a depression, and the irregularities of the pods (Fig. 9, *d*, *e*; Fig. 10, *b*, *c*) which have been considered characteristic of the fruit of the genus are chiefly due to these punctures, which, ordinarily occurring just below the middle of the pod, produce a more or less marked constriction there.

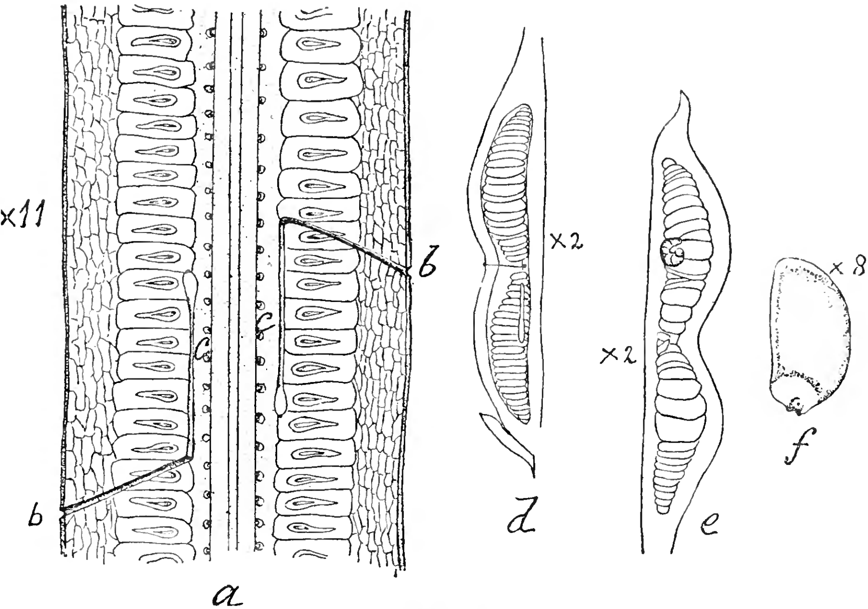


FIG. 9.—*a*, longitudinal section of pistil of *Yucca filamentosa*, showing (*b*, *b*) punctures of Pronuba, and (*c*, *c*) the normal position of her eggs in the ovarian cell; *d*, section of a punctured carpel seven days after oviposition, showing the egg yet unhatched and the manner in which the ovules in the neighborhood of puncture have been arrested in development so as to cause the constriction; *e*, section of an older carpel, showing the larva above the original puncture; *f*, a seed thirteen days from oviposition, showing young larva at funicular base.

This I have often proved by artificially pollinizing the flowers and protecting them from Pronuba, when the pods will develop in a regular, parallel-sided manner (Fig. 10, *a*).

It is noticeable that all the pods do not contain Pronuba larvæ, though we rarely find any on the filamentose species that do not show the marks of puncture, which indicates that a great many punctures are fruitless in result, owing either to the difficulty of the operation of oviposition, or to the fact that the eggs, having been once consigned to the pistil, have failed to hatch, for one reason or another; or again, that the larva has, for one reason or another, perished. A similar mortality is connected with the similarly difficult and complicated oviposition of the *Cynipidæ*, as Adler has shown. In dissecting the young fruits of the filamentose yuccas, with a view to critical examination, I have found that about half of them, on the average, contain nothing; but the proportion varies greatly in different localities and according to circumstances, and I may say that, as a result of my numerous examinations, fully two thirds of the mature pods are found to contain the larvæ of Pronuba. All the experiments which I have so far made, or have known to be made, prove conclusively that the capsular species never set fruit without her aid.

Pronuba yuccasella is found in all parts of the country east of the Rocky Mountains where the filamentose yuccas normally range; but has not extended to all sections where they are cultivated. The time of its appearance is strikingly coetaneous, east

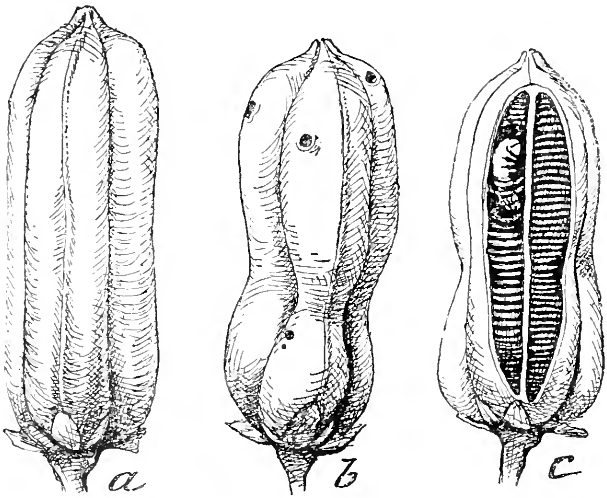


Fig. 10.—Mature Pods of Yucca angustifolia: *a*, artificially pollinized and protected from Pronuba; *b*, normal pod, showing constrictions resulting from Pronuba puncture and exit-holes of larva; *c*, one of the lobes cut open, showing larva within.

of the Mississippi, with the blooming of *filamentosa;* while other cultivated species which bloom either earlier or later, and which, therefore, do not receive the visits of the moth, I have, as already stated, never known to bear seed. On the Western plains, where *Y. angustifolia* is native, the moth's season of appearance is adapted to the flowering of this particular yucca. In California, *Yucca whipplei* is pollinized by *Pronuba maculata,* an invariably maculate species; while, on the Mojave Desert, *Yucca brevifolia* is pollinized by *Pronuba synthetica,* a species still more abnormal than *yuccasella* and modified to fit it to the peculiarities of that particular species of yucca. In the Gulf States the typical *yuccasella* occurs, and fertilizes not only the filamentose yuccas, but those individuals of the larger, fleshy-fruited species like *aloifolia* which happen to bloom about the same time of the year.

Thus we find that some species of Pronuba is connected with all the yuccas so far studied in this connection, and I have no doubt that this will be found to be generally true, so far as the indigenous species are concerned, and that in the native home of any of the species we shall find that pollination depends upon some species of Pronuba. This is rendered certain by the fact that, wherever I have been able to examine the mature or partially mature fruit of other yuccas in herbaria, I have in almost every instance observed the constriction and in most instances seen traces of the puncture and the work of the larva.

We have, in the structures and functions which are so characteristic of this yucca moth, admirable adaptations of means to an end, whether for pollinizing the plant or providing for a future generation. The Pronuba larva rarely destroys more than a dozen of the seeds, so that several may develop within a single pod and yet leave many perfect seeds, while, for the reasons already stated, we occasionally have pods without a trace of the insect.

There is between Pronuba and its food-plant a mutual interdependence which excites our wonder, and is fraught with interesting suggestions to those who are in the habit of reasoning from effect to cause. Whether we believe, as I certainly do, that this perfect adaptation and adjustment have been brought about by slow degrees through the long course of ages, or whether we believe that they were always so from the beginning, they are equally suggestive. The peculiar structure of the flower which prevents self-fertilization, though on a superficial view it strike one as a disadvantage, is, in reality, of benefit, as the value of cross-fertilization has been fully established; while the maxillary tentacles of the female moth are very plainly an advantage to her species in the "struggle for life"; and it is quite easy to conceive, on Darwinian grounds, how both these characteristics have been produced in the course of time from archetypal forms which possessed neither, and in reality we get a good insight into the process in studying the characteristics of other species of the family *Prodoxidæ.* These peculiarities are, moreover, mutually and reciprocally beneficial, so that the plant and the animal are each influenced and modified by the other, and the same laws which produced the beneficial specialization of parts will maintain them by the elimination of all tendencies to depart from them.

The pollen grains would not adhere by chance to the rolled-up tentacles, and we have seen how full of apparent purpose and deliberation Pronuba's actions are. It may be that all her actions are the result merely of "blind instinct," by which term proud man has been wont to designate the doings of inferior animals;

but no one can watch her operations without feeling that there is in all of them as much of purpose as there is in those of the female Pelopæus who so assiduously collects, paralyzes, and stores away in her mud-dabs the spiders which are to nourish her young; or in the many other curious provisions which insects make for their progeny, which, in the majority of instances, they are destined never to behold. Nor can I see any good reason for denying these lowly creatures a degree of consciousness of what they are about, or even of what will result from their labors. They have an object in view, and whether we attribute their performances to instinct or to reason depends altogether on the meaning we give to those words. Define instinct as "congenital habit" or "inherited association" or, as I prefer to characterize it, as *the inevitable outcome of organization*, and most of the doings of the lower animals may justly be called instinctive; but instinct and intelligence are both present, in most animals, in varying proportion, the last being called into play more especially by unusual and exceptional circumstances, and the power which guides the female Pronuba in her actions differs only in degree from that which directs a bird in the building of its nest, or which governs many of the actions of rational men.

THE SURVIVAL OF THE UNFIT.

By HENRY DWIGHT CHAPIN, M.D.

IS modern civilization advancing along satisfactory lines toward a higher development? We hope and believe so, but there are not a few who consider such a question an open one. Both the pessimist and optimist can have much to say on either side of this problem. The forces at work in society are diverse and complex, acting like the ceaseless operation of a complicated engine that is constantly pushing on, throwing some up and some down, and leaving many a wreck behind. It is of pregnant interest to study the destructive factors at work in society that not only produce the unfit, but also tend to their survival. This question derives its principal significance from the apparently hopeless task of dealing with the unfit. Science and theology, from widely divergent poles, appear to reach much the same conclusion with regard to delinquents. Darwinism and Calvinism present about an equally hopeful consideration for the unfortunates of our race. One says heredity and environment; the other, predestination and foreordination. Both suggest the witty aphorism of Dr. Holmes, that the proper time to begin the treatment of some diseases is a hundred years before birth.

A glance at some statistics, published in the United States census reports will be interesting in this connection. The following figures are taken from a table showing the number of insane, idiotic, blind, and deaf-mutes in the United States, in the years named, respectively, according to the census:

	1880.	1870.	1860.	1850.
Defectives	251,698	98,484	68,451	50,994
Total population	50,155,783	38,558,371	31,443,321	23,191,876

According to these figures, the population a little more than doubled in thirty years, while the number of defective persons returned was nearly five times as great as it had been thirty years before. During the decade from 1870–'80 the increase in population was 30 per cent; during the same interval of time the apparent increase in the defective classes was a little more than 155 per cent. There is much talk about the increase of insanity in our day, and statistics appear to bear witness to the truth of such reports. The following shows the ratio of insane population to the entire population for the whole country in different years: *

1860 .... 1 to 1,310.
1870 .... 1 to 1,100.
1880 .... 1 to 570.

The latest report of the Census Bureau states that the total number of insane persons treated in both public and private institutions during the year 1889 was 97,535, while during the year 1881 there were 56,205 treated; showing an increase in the nine years of 41,330, or 73·53 per cent. This percentage of increase, when compared with the percentage of increase of population in the last decade, namely, 24·86, does not necessarily indicate an increase in the proportion of insane persons to population, but rather a great increase in the amount of asylum accommodation provided, and a willingness on the part of the public to make full use of all the facilities thus offered. The bulletin states that the figures for the actual number of insane in the United States can not be determined until the work of eliminating all duplicate reports of cases has been completed.

The ratio of insane in public and private institutions of the United States is to the entire population as 1·56 to 1,000.† As these figures represent only institutions to which large numbers of the mildly insane are never sent, they point to an increase in insanity. Objections may be made to figures tending to show a

* Dr. C. L. Dana, in Journal of Nervous and Mental Disease, April, 1882.

† Census Bulletin, No. 62, May 9, 1891.

relative increase of the defective classes, on the ground that statistics are now much more carefully collected than formerly, which is certainly true. It may be said, however, that errors in the returns of the defectives were not confined to this class, but were more or less distributed among the different elements of population. The accurate collation of defectives is a task of great difficulty. While their number is now relatively better known than formerly, their absolute number will never be as accurately tabulated as other parts of the community, but a study of statistics shows that they tend to increase.

With regard to paupers, the recent census shows the total number in almshouses to be 73,045.* The number reported in 1880 was 66,203. The ratio of almshouse paupers to the total population at that time was 1 to 758; the ratio in 1890 was 1 to 857, showing a decrease. This decline in the ratio is attributed to the very much smaller number of paupers cared for in the almshouses in the North Atlantic division. It is interesting to note that the foreign population of this country contributes, directly or indirectly, very nearly three fifths of all the paupers supported in almshouses. There is no way of learning the number of outdoor poor—which is large—as they are supported, partly or in whole, by private charity. Mrs. Lowell estimates that the number of paupers in the public and private institutions of New York city, totally supported at any one time, is about 28,000. The cost of maintaining them during 1890 was $3,794,972. She further states that, if we go back forty years, we find that the increase of contributions of public funds to private persons for the support of private paupers has been from $9,863 in 1850 to $1,845,872 in 1890, and that the amount is nearly two hundred times what it was forty years ago. The increase of expenditure for public paupers, through the hands of public officials, has been at a much less ratio, increasing from $421,882 to $1,949,100 during the same interval of time.†

What is society to do with its horde of defectives? Unfortunately, it does practically nothing to check their production. The sources of the muddy stream are left untouched, while larger and larger reservoirs are being constantly built to collect and conserve the contaminated flow. One can not help noticing how this humanitarian age is abundantly equipped with asylums, almshouses, reformatories, and hospitals of all kinds. If the good accomplished by such agencies could be measured solely by relief of suffering and cure of disease, the results would be nothing but gratifying. A collateral danger is in keeping alive

* Census Bulletin, No. 90, July 8, 1891.

† Christian Union, August 25, 1891.

sickly and defective classes, who are often as prolific as they are inefficient. In our civilization these institutions have become a necessity, but their abuse should be carefully guarded against. What is urgently needed are homes or retreats where poor convalescent patients can recuperate after their discharge from the hospital. As it is, such people, in a weakened condition, have no place to seek the needed rest, and either fall victims again to a former disease, or become chronic invalids. Here would seem to be a more fruitful field for philanthropy than the building of additional hospitals. Above all, more of an effort should be made to get at the roots of the cause than to temporize so with the effect. Municipal governments annually devote large sums of money for the care of the sick, the criminal, and the insane, but devote no energy to investigating and striving to prevent the factors that are constantly at work in producing these classes. Here, if ever, an ounce of prevention is equal to many pounds of cure. The Department of Public Charities and Correction of New York city, with its 15,000 wards, received $2,166,237 in 1891, and requests an appropriation of $2,877,245 for 1892. If a part of the money that is annually devoted to keeping alive the helpless and suffering could in some way be diverted toward remedying unhealthy domiciles, relieving overcrowded tenements, dissipating polluted air and foul gases, supplying the best food at cheap rates, educating the masses in the simple principles of hygienic living, closing the saloons, and in many like ways checking the sources of disease and degeneration, this knotty problem would find its best solution. The way we can cure is by preventing. We permit factors to exist that degenerate men physically, mentally, and morally, and then bring up a clumsy, mechanical, outside philanthropy to try and reform by patchwork.

Probably one of the greatest dangers to organized society is found in the criminal classes. The laws of the production and confirmation of criminals, with their treatment, should be among the most thoughtfully studied branches of political science. The number of convicts in penitentiaries in 1880 was 35,538, while in 1890 it was 45,233, an increase in ten years of 9,695, or 27·28 per cent, and during this interval the total population increased only at the rate of 24·86 per cent.* Again, the total number of prisoners in county jails in 1880 was 12,691; in 1890, 19,538, an increase in ten years of 6,847, or at the rate of 53·95 per cent.† Coming to the inmates of juvenile reformatories, we find the number reported in 1880 was 11,468; in 1890, 14,846, an increase of 3,378, or

* Census Bulletin, No. 31, February 14, 1891.

† Census Bulletin, No. 95, July 14, 1891.

29·46 per cent.* It is thus shown by recent statistics that the various grades of criminal population are increasing more rapidly than the population at large. The same results have been shown by previous census reports. It must also be remembered that a large number of actual criminals are not under confinement, and are hence not included in the figures showing their increase. It has evidently become a vitally important question for decision by society as to the best plan to pursue toward the criminal. In dealing with this problem too much stress is popularly laid upon merely punishing the malefactor. Popular conceptions of the nature of punishment have varied widely with the age. The earliest enactments of penalty were, in form, vindictive; next retributive; and, finally, as the highest conception, reformatory. While the State, uninfluenced either by vindictive feeling or pity, deprives criminals of liberty for a time as a measure of self-protection, it must adopt some mode of treatment during incarceration. The old plan consists in getting a certain amount of work out of them to aid in their support, but without making any effort at reform. The unexpressed idea appears first to get even with them, and then kick them out upon society, usually to begin depredations again. An abnormal mental and moral atmosphere is diffused in such a prison, and the large congregation of criminals is a school for confirming the vicious. The reformatory plan aims at the prisoner's rehabilitation, so that there may be some hope of right behavior after release. This result is sought by means of physical renovation, industrial and intellectual education, and general moral impression. In order to satisfactorily apply these agencies the science of penology has shown an indefinite sentence with a conditional discharge, including partial oversight after discharge, to be necessary. It is a fact proved by statistics that a large percentage of criminals are defective either physically or mentally, and have had an unfavorable heredity and environment.† Under the general system in this country no attempt is made to rehabilitate them during confinement. Criminals are first made to a certain extent by unfortunate heredity and unfavorable social conditions, and then confirmed by imprisonment. Weak character and environment bring out the unfittest elements, and society by its treatment hastens to provide for their survival. When we see that, accord-

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* Census Bulletin, No. 72, May 27, 1891.

† Of 552 convicts received at the State Penitentiary for the Eastern District of Pennsylvania in 1886, 263 were found in a condition of impaired health, and 174 were in an unsound mental condition, as follows: Insane, 12; epileptics, 7; mentally undeveloped, 61; weak intellect, 77; idiotic, 17: 159 were inclined to grave diseases of the neurotic type, which tend to modify the moral, mental, and physical condition from inheritance of bad formation.

ing to past census reports, crime has more than doubled every ten years for the past half-century, the importance of this subject becomes manifest. The most practical and successful trial of the advanced method in this country is seen at the Elmira Reformatory. Here the prisoner goes to school and receives the needed bodily and mental training, by which it is endeavored to form a stable base for moral improvement.

In conclusion, we must repeat that, in our consideration of the defective and delinquent classes, more attention should be given to *prevention.* Let our greatest energies be devoted to combating the conditions that are at work in society producing the unfit, rather than so industriously providing for their survival. When such a class is formed, it should be permanently isolated from the rest of society. Recent legislation in Ohio adjudges a person an habitual criminal when convicted of a third offense, under which he may be held for life. This law is based upon sound physiology and psychology. Such a permanent quarantine should be applied to all tramps, cranks, and generally worthless beings. Society must do this for protection, not punishment; to avoid their contamination; and, above all, to prevent the propagation of their kind. Advanced sociology will devote its principal energies to avoiding the production of the unfit, and then see to it that they do not survive beyond one generation. Here lies the only solution of this difficult problem—first prevention, next permanent isolation.

THE ANCIENT CIVILIZATIONS OF AMERICA.

By Prof. JOHN S. NEWBERRY.

WHEN the white man landed on these shores he found them covered with a dense forest, the home of the bear, the elk, the lynx, and the other wild animals indigenous to this country. The only human inhabitants were the red Indians, who roved the forest, "the children of the shade"—the chase their occupation, and their amusement war. From Maine to Florida the country was overrun by various tribes of these untutored savages, and for many years it was believed that the whole of North America was what it was called—*the New World*—and that its animals and savage men were part of the first wild stock with which it was peopled.

As the wave of civilization moved westward the forest was mowed down before it, and step by step the native tribes—with many a hard-fought battle and bloody tragedy—were driven deeper into their forest recesses.

Behind the advance guard of the whites the country was soon dotted with hamlets, which grew to towns, and these in time to cities. The intervals between them were covered with grain-fields and orchards, of which the growth was so luxuriant that it seemed to prove the soil to be now for the first time opened to the sunlight. Thus several generations passed; but in time the invading hosts pressed through the great natural water-gap, which once connected the Hudson with the lakes, or crossed the Alleghanies from Pennsylvania and Virginia, and took possession of the basin of the Ohio. Here they entered their promised land—the valley of the Mississippi—a region which by its broad topographical unity, its universal fertility, its network of navigable waters, and its unequaled mineral resources, is without a rival on the earth's surface in its fitness to become the home of a great nation. Here, too, the wandering and stealthy savage was in full possession, and resisted the invasion of his hunting-grounds with his characteristic ferocity.

Ultimately, however, he was compelled to yield to the superior numbers and intelligence of the whites, and, within fifty years from the first struggle on the "dark and bloody ground" of Kentucky, he had practically abandoned all the territory east of the Mississippi.

When the forests were opened in this region, it was for the first time discovered that the nomadic Indian was not autochthonous, and that he had been preceded by a sedentary and partially civilized people, who had cultivated the soil, worked the mines, and left behind them a vast series of monuments which extended from the Alleghanies to the prairies, from the Lakes to the Gulf. These monuments consisted of *mounds, walls, fortifications,* and other structures composed of earth or rough stone, and among them the mounds (chiefly sepulchral) were so conspicuous from their numbers and size that the people by whom they were constructed—and whose name and history had been utterly lost—for want of other designation were called *the Mound-builders.*

The records of this ancient people, with the lessons they teach in regard to their degree and kind of culture and their ethnical relations, will be referred to again. Meantime we will pass to notice a still more extensive and interesting series of monuments which attest the ancient occupation of America by *civilized* man.

Long before the Northern whites had entered the valley of the Mississippi, and had discovered the first traces of the mound-builders, the Spaniards who invaded Mexico and Peru found there a civilization in many respects superior to their own—a civilization which extended throughout Mexico, the Isthmus, and the west coast of South America to the frontiers of Chili; that had produced cities that rivaled in extent and in the magnificence of their buildings those of the Old World—cities that were lighted at night, guarded by police, that contained palaces, temples, courts of justice, schools of law, medicine, music, and literature, with parks, aqueducts, fountains, and artificial lakes.

The cities were connected by graded roads, on which were stations and relays of messengers for the rapid transmission of intelligence. The population was divided into various castes, including royalty, nobility, different grades of traders and artisans, and finally slaves. The country was cultivated with much agricultural skill, and in the towns were workers in *gold, silver, copper,* and *bronze.* Their military organization was thorough and effective, and strategic points were guarded by fortifications, some of which have had no rivals in magnitude in the history of the world.

This civilization, imposing as it was, at the advent of the Spaniards had passed its golden age, was then in its decadence, and has since, chiefly by the brute force, cruelty, and rapacity of the European invaders, been nearly driven from the earth.

So much has been written of these two American civilizations —that of the mound-builders of the Mississippi Valley, and that of the palace-builders of Central America—and their study has been pursued with so much interest and success, that it may seem presumptuous that I should venture to occupy the hour kindly granted me with a theme so broad and already so familiar. But it has happened to me to traverse much of the territory in Central America, Mexico, and the United States where the relics of these bygone races are most abundant, and as the subject has always been one of intense interest to me I have lost no opportunity of gathering by my own observation such information as came within my reach; hence, it is possible that I may be able to contribute something to what you may have learned of our predecessors in the occupation of this continent, and of the real and original American citizen.

THE MOUND-BUILDERS.—As has already been mentioned, traces of a people more advanced in the arts than the nomadic Indian are spread over the entire valley of the Mississippi and the Lake basin. These have been so fully described that you are familiar with their general character, but few of us have a just idea of their number and magnitude.

It is estimated (but I fear with little accuracy) that not less than ten thousand monuments of the mound-builders are contained within the limits of Ohio, and they are scarcely less numerous in the adjacent States of Indiana and Kentucky. In some places, as at Newark and Circleville, they cover square miles of surface, and it is hardly to be doubted that they are the work of a people or peoples not less numerous than the present population.

They are most abundant where the agricultural capabilities of the country are greatest, and we find them associated with areas of special fertility in such a way as to prove that they had stripped the forest from these areas, and chiefly derived their subsistence from their cultivation. Hence we learn that they were a sedentary and agricultural people. Yet their structures are for the most part earthworks—walls for defense, or to form inclosures, sepulchral mounds, etc.; and while we find what seem to be raised foundations of extensive buildings, those buildings have disappeared, and we must hence conclude that they were for the most part structures of wood.

The mound-builders were ignorant of the use of iron, and probably possessed no other metals than copper, which they mined extensively, but never smelted; for we find their implements composed of the native metal, often with specks of silver, thus betraying its source on Lake Superior, and only hammered into shape. From this copper they made battle-axes, daggers, knives, awls, and ornaments; but most of their tools and weapons were of stone, and many of them were laboriously and tastefully wrought.

They have left no evidence that they had a knowledge of masonry—an art in which the inhabitants of the table-lands so much excelled.

This is the more remarkable, as stone easily quarried abounds in the vicinity of their works, and some of the great structures of our Western table-lands, whose builders apparently had not the use of metals, show what good work could be done without metallic tools.

I have said that the mound-builders made use of but a single metal—copper—and yet they were industrious and enterprising *miners*. Their copper mines on Lake Superior have been often and fully described. They must have been worked for generations, since the ancient excavations exceed in magnitude all the work of the white man in that region; but the methods which they used were exceedingly rude and simple.

They had no knowledge of metallurgy, and the Lake Superior copper was only available for their purpose *because* it occurs in the metallic state. They excavated the rock by the use of fire, stone hammers, and wooden shovels.

They never penetrated the earth to a greater depth than sixty to eighty feet, and for ladders they used the trunks of trees from which the branches projected at frequent intervals, and these were cut off to form steps. Since no considerable structures belonging to this people have been found near the Lake Superior mines, it seems probable that their mining operations were carried on only in summer, and by parties who, migrating from the lower country in the spring, returned in autumn.

Although the copper mines of the mound-builders were their most important ones, they had others by which they procured things that were of no less value to them. Of the coal, which constitutes the mainspring of modern civilization, and of iron, its most important adjunct, though existing in unequaled abundance in the country they inhabited, and trodden under foot in their daily vocations, they seem to have been utterly and strangely ignorant. Yet they worked with much labor the *mines* of *mica* in North Carolina, from which they procured what was by them highly prized as an ornament; *the soap-stone quarries* of the Alleghany range, where they obtained material for their domestic utensils and the all-important ceremonial pipe; and those of flint in Ohio and elsewhere, from which came the material out of which the greater number of their tools and weapons were fashioned.

In addition to these, I can assert from my own observation that they worked at least *one lead mine* in Kentucky, and sank wells from which they obtained petroleum in all our principal oil regions.

As these facts have not been reported by others, and yet are unquestionable, I venture to emphasize them with a few words of description.

Near Lexington, Ky., is a vein of lead ore which is traceable for half a mile or more through cultivated and forest land. The ore is galena in heavy spar, which has resisted the solvent carbonic-acid water that has removed the limestone wall rocks and shows conspicuously at the surface. Thus it attracted the attention of the mound-builders, who seem to have prized the galena only for its brilliancy, as we find it in many of the mounds, but so far we lack evidence that it was smelted. To obtain it in the mine to which I have referred, they made a deep trench along the course of the vein, taking out the ore to the depth of perhaps ten or twenty feet. One hundred yards or more of this trench is now visible, running through forest which has never been disturbed by the whites. Here it is five or six feet deep, and is bordered on either side by ridges of the material thrown out. On these, trees are growing which have reached their maximum dimensions, showing that at least five hundred years have elapsed since the mine was abandoned.

The working of the oil wells by the mound-builders is as plainly proved. When drawn to Titusville by the first successful oil wells, I was struck by the peculiar pitted surface of the soil of the forest which covered the bottom lands of Oil Creek. The pits were ten feet or more in diameter, and two to three feet deep, contiguous, and innumerable. Subsequently I discovered that each of these funnel-shaped depressions marked the site of an ancient well, sunk through the alluvial deposits, but not into the rock.

One of these, just opened in an excavation for a new oil well, showed a pit twenty-seven feet deep, cribbed up with timber, and containing a rude ladder like those found in the Lake Superior copper mines. The timber used for the inclosure of the ancient pit had been cut with a blunt-edged instrument, doubtless of stone.

I afterward found similar pits in the oil regions of Kentucky and Tennessee, at Mecca and Grafton, Ohio, and at Enniskillen, in Canada. In the latter locality the oil was obtained by sinking pits to the depth of forty or fifty feet in the Drift clay, the oil issuing from crevices in the underlying rock and accumulating beneath the clay. In the excavation of one of these pits an ancient one of similar character was brought to light. This was filled with rubbish, twigs, leaves, etc., and a pair of antlers was taken from it at a depth of thirty-seven feet. The antiquity of this pit, like those of Oil Creek, was proved by the large trees growing over it.

The contents of their sepulchral mounds have supplied some information—though less than we desire—of the domestic habits of the mound-builders. Usually the bones they contain are so much decomposed in the lapse of time that they have given us but an imperfect knowledge of their osteology. From the few remains found well preserved we may, however, infer that as a people they were of average size, of fair proportions, and with a cranial development not unlike that of our modern Indians. The jaws were somewhat prognathous; their teeth—as is usual with all peoples who make much use of their jaws *for mastication*—are strong and regular; and the wisdom-tooth, which in our jaws, shortened by disuse, has inadequate room and is of little value, was with them one of the largest and most useful of the set. On account of the lengthened under jaw, the incisors met in direct opposition, and apparently because they used their teeth for grinding seeds of which the envelopes contained much silica, they are often found uniformily worn down nearly to the jaw. We know little of the crops the mound-builders cultivated except that their great staple was corn, and that they raised and used tobacco.

They buried their dead with imposing ceremonies, and not unfrequently cremated their remains on a kind of altar which occupies the center of the sepulchral mound, and, as is the habit with perhaps all primitive people, vases, weapons, tools, and ornaments were buried with the body. Of these the pottery sometimes shows considerable taste and skill—the vessels having graceful forms and being often ornamented with colors or with incised designs. The weapons and implements that are found so abundantly in the mounds and scattered over the surface are rarely of copper, generally of stone. Of these the arrow-heads, spear-heads, daggers, augers, and hoes are usually of flint; their axes and celts are generally made of green-stone, a tough and heavy rock specially adapted to such use; the celts were inserted in handles and closely resemble those of the polished-stone period in the Old World. Their axes, all grooved for a withe, were frequently wrought with great skill and patience. The most common ornaments found with the remains of the mound-builders are anklets or armlets of copper, and strings of beads of shells or bone, of copper or baked clay. In addition to these are many large ornaments of shell or stone perforated for suspension from the neck or for attachment to the head.

Of the clothing of the mound-builders we have as yet little information, since the lapse of time has caused fabrics of vegetable or animal fiber to perish. In a few instances, however, the antiseptic properties of copper salts or special conditions have been the means of preserving some fragments of cloth made from the fibers of a plant. Of these the workmanship is so good that we may believe that woven fabrics were largely used for clothing.

In regard to the ethnic relations of the mound-builders, the age in which they lived, and the causes of their disappearance, much has been conjectured, but little can be asserted. As to the time in which they lived in the country they inhabited—when and how long—this at least may be said, viz., that they occupied all the forest-covered region of the Mississippi Valley—to which they seem to have given a decided preference—for many hundreds and perhaps thousands of years. This is indicated by the general occupation of this wide-spread area, the magnitude and number of such of their works as have resisted the ravages of time, and the great abundance of the stone implements of their manufacture found scattered over the surface; also by the extent of their mining operations on Lake Superior and elsewhere. All this can mean nothing less than the long-continued possession of the country.

The general distribution throughout the valley of the Mississippi of shells obtained on the Gulf or Atlantic coast; the copper, mica, galena, flint implements, etc., all of known origin, indicate considerable internal interchange of commodities, but furnish no proof of a foreign commerce.

In regard to the origin of these peoples little is known. We may infer from their bony structure that they belonged to the American family of men, and were not unlike, in structure, physical aspect, and color, the red Indian of to-day.

A few stone tablets have been found in the mounds, which are decidedly Mexican in character; and if, as seems probable, the authenticity of these relics should be established, they would go far to prove synchronism and intercourse between the mound-builders and civilized races of the South; but this does little or nothing toward establishing a relationship between them.

As to *when* and *why* and *how* the mound-builders disappeared we can form a more accurate and reliable conception. A large number of the monuments left behind by them are of a defensive nature; in some localities, as in the valley of the Cuyahoga, near Cleveland, every headland which overlooks the river is crowned with a fort or citadel; and it is evident that those who occupied this and many other areas of the Mississippi Valley were engaged in a constant struggle with persistent, harassing enemies.

Following the migrations of the various tribes of the modern Indians (as we are able to do chiefly by the clew of language) we learn that they have come from the North, and have for hundreds of years been pushing by devious and interlacing routes southward to occupy the territory once possessed by sedentary, peaceful, and agricultural peoples—the mound-builders in the East and the stone-house builders in the West.

Limitation of time forbids the citation of the proof of this northern invasion, but it is sufficient to convince those who have most carefully studied the subject. We may therefore accept the conclusion that in America, as in Europe, hordes of northern barbarians (multiplied by the fecundity of a cool and healthful climate, and inspired by the force and restlessness acquired in their strife with Nature's obstacles) invaded southern lands whose more fertile soil and genial but enervating climate developed the arts of peace at the expense of those of war.

The commoner belief has been that the ultimate fate of the mound-builders was entire extinction; but there is good reason to believe that in the Natchez and Mandans, and perhaps some other tribes still existing, but in small numbers, at the advent of the whites, we have their lineal descendants. The grounds of this conclusion can not be fully set forth here, but it may be said that the tribes referred to in many respects contrast strongly with the more numerous and characteristic inhabitants of the country; and also that their customs and arts, their implements and structures, bear a close resemblance to those of the former occupants of the Mississippi Valley.

As to the time which has elapsed since the mines and structures of the mound-builders were abandoned we have only negative evidence. The heaps of *débris* about the Lake Superior copper mines, the filled-up oil wells, and the earthworks of Ohio, Kentucky, and Tennessee, were found by the incoming whites covered with dense forests in which the trees had attained their maximum size. Beneath this present generation of trees, and overgrown by their roots, were lying the prostrate and decaying trunks of a preceding generation. We thus have evidence that at least a thousand years had elapsed since the country was *abandoned* by its former inhabitants, and their fields and villages were overgrown by the forest. Beyond this point all dates are left to conjecture.

One interesting feature in the Western mounds is that many of them, especially in the prairie regions of the Northwest, are made to imitate, on a gigantic scale, the forms of men, quadrupeds, and birds, and among the animals thus represented is what seems to be the elephant or mastodon. Small figures of an elephantine animal also appear in the archæological collections of the Northwest, and are claimed to be authentic. These relics go far to prove the acquaintance of the mound-builders with either the mastodon or mammoth, and may be accepted as presumptive evidence of the synchronism of man here, as in Europe, with one or both of these great pachyderms—and hence of his great antiquity.

The Palace-builders.—The remains of an ancient civilization, scattered over the west coast of South America, the Isthmus, and Mexico, are so varied and interesting that they form a theme to which nothing like justice can be done in the few minutes at my disposal. Detailed descriptions of these great monuments are, however, the less necessary, since many volumes have been devoted to their exposition. Those who have access to Squier's Peru, Stephens's and Catherwood's, Norman's and Waldeck's books on Central America, or Lord Kingsborough's great work on Mexican Antiquities, will find there, and in the documents cited by their authors, a literature scarcely less rich and interesting than that formed by the records of the Egyptians or Assyrians.

Of this vast field I can give you but the merest sketch, but, as part of it lies within our own territory, and as in its exploration I have taken part, I can perhaps add some facts additional to those you have learned, and such as will compensate for the time they may occupy. To summarize, as briefly as possible, the knowledge we have of this subject, I may say that from the frontier of Chili to Salt Lake, there exists an almost uninterrupted series of monuments of a civilization which, though locally peculiar, was generically the same, and unquestionably the product of divergent streams flowing from a single source. The typical and characteristic remains of this civilization consist of great works of masonry and engineering (fortifications, temples, palaces, communal houses), which in their magnitude and perfection of workmanship rival the masterpieces of ancient architecture. Bridges, aqueducts, and thousands of miles of paved and graded roads attest the engineering skill of the people by whom they were constructed.

Honduras, Yucatan, and Colombia would seem to have been the center of this civilization. It is true that the monuments of Peru are equally extensive and imposing as those already discovered in Central America, but they are far better known; and we have reason to believe that, buried in the almost impenetrable forests of Honduras and the Isthmus, there still remain more extensive and interesting ruins than any yet brought to light. There is little doubt that here we have the richest field for future explorations, and a source from which we may hope for more light upon the history of the peoples whose works we are considering.

In regard to these peoples, however, there is no such mystery as clings about the mound-builders. Though stripped of much of its former power and glory, the civilization of the Incas and the Aztecs was still in active life at the time of the invasions of Cortes and Pizarro; though, under the hand of the oppressor, the native population, with all its complicated systems of laws, religion, customs, and literature, was rapidly destroyed or degraded beyond recognition. As we know, the chronicles of the old Spanish historians are somewhat highly colored, and the wealth, magnitude, and splendor of the cities they conquered were magnified by the Spaniards to enhance the glory of their exploits. There can be no doubt, however, that in both North and South America there were found civilized and wealthy nations, far advanced in all the arts then known in Europe, except the working of iron, and with a perfection of political, social, and religious organization that can not fail to excite our wonder and admiration.

As proof of the reality of the advancement in the arts and the solid achievements of the Peruvians, Mr. Squier tells me that the great Incarial road, which reaches from Quito to Chili, is a work of far greater magnitude than our Union Pacific Railroad; that some of the public buildings of the Peruvians were constructed of masonry that in its perfection is not surpassed by the finest monuments of ancient or modern architecture; also, that a single fortress guarding one of the passes through which the wild hordes of the upper Amazon sometimes entered Peru, was a mightier mass of masonry than would be formed by heaping together all the forts upon our coasts from Maine to Mexico.

As an evidence of the wealth of the country, it is reported that the gold and silver vessels brought for the ransom of Atahualpa, and which, as we read, filled his prison as high as he could reach, had a value of something like twenty-five hundred thousand dollars; and it is said further that the gold plates and ornaments stripped from the Temple of the Sun at Cuzco were worth not less than one million dollars.

The essential unity of the civilization which covered all the country containing the monuments referred to is attested by the resemblances in religion—for all was sun-worship—in language, in customs, in style of building, and especially by a peculiar skill in the construction of works of masonry, in the manufacture of pottery, and in ornamental decoration. That there were marked local differences, and that this civilization was shared by independent nationalities, is certain; but it is no less true that it sprang from a common source, and was harmonized by constant intercourse through hundreds and it may be thousands of years.

Since a large population was found inhabiting the cities and embodying this civilization at the time of the conquest, it would seem that everything important could be easily learned about this peculiar phase of human development. But it should be remembered that the propagation of the Christian faith was a motive only less strong than the thirst for gold in the Spanish invaders, and a bigotry ferociously intolerant of all heresy made it a cardinal virtue to destroy every representative of pagan creeds and rites.

Hence from religious as well as political causes the conquest was followed by a destruction which soon swept away nearly all traces of the literature, customs, and government of the conquered people, and did all that was possible to bury their history in oblivion. Fortunately, among the numerous monks who attended the invading armies were a few possessed of scholarly tastes, who described what they saw, and, perhaps surreptitiously, translated some of the ancient hieroglyphic records, and preserved vocabularies of some of the dialects then in use. These have furnished a clew to the interpretation of some at least of the abundant inscriptions in Central America, and we can not doubt that by the earnest following of this clew, and the patient application of the methods which have revealed the secrets of the Egyptian hieroglyphics and the Assyrian cuneiform characters, we shall obtain from the Central American records much light upon the history of the civilization we are considering.

In Mexico and Peru few inscriptions are preserved, and yet we know that the art of writing on paper, or its equivalent, was practiced in both countries.

Unfortunately, it was not the habit of these peoples, any more than it is with us, to make enduring records on stone, and the loss of the ephemeral manuscripts which existed at the time of the conquest is an irreparable one. There is little doubt, however, that when the inscriptions of Palenque, Uxmal, Copan, Chichenitza, etc., shall be translated, the mystery which has so long hung over the origin and progress of all this phase of intellectual culture will be dissipated.

Those who believe—as some do—that the Peruvian civilization is distinct from and totally independent of that of Central America and Mexico, will not share the hopes I entertain from the translation of the abundant records of Yucatan. But no one can compare the pyramidal structures of central Mexico, Tehuantepec, and Huanaco, or the style of architectural ornamentation of Mitla, Uxmal, and Granchimu, without feeling that they are the work of a people who were generically the same. The striking and peculiar images in gold, silver, and alloy, as well as the pottery of Perù, of Bogotá, and Chiriqui, afford confirmatory evidence of this unity.

The intercourse between these neighboring and cognate nations was undoubtedly for the most part by sea. Columbus met traders from cities of Central America at Ruatan, where they came in a vessel of considerable size, carrying sail and manned by twenty sailors; and Pizarro, on his way to Peru, when near the equator, encountered a vessel of the Peruvians, which he says "was like a European caravel," and was loaded with merchandise, vases, mirrors of burnished silver, and curious fabrics of cotton and wool, the latter undoubtedly made from the wool of the llama. With such vessels it would be easy to pass from the Mexican to the Central American and thence to the South American ports; and we have incidental evidence that this was done. Louis Hoffman, a German mining engineer, who was one of the scientific corps attached to the staff of Maximilian, and who on professional duty visited all the mining districts of Mexico, tells me that on the Pacific coast, directly south from the city of Mexico, in a region abounding in ruins yet unstudied, at the mouth of a river, is what was once a large seaport town. From this point the passage would be direct and easy to Tehuantepec, Panama, and thence southward.

The question of the origin of the Mexican and Peruvian civilization has been much discussed, and various views have been advanced in regard to it: by some, that it was the fruit of seed borne across the Atlantic by the Phœnician traders, and was therefore of European origin; by others, that it was a remnant of the civilization that pervaded the fabulous country of Atlantis, which once stretched from Central America far over toward the Old World, from which it was separated by a strait that was easily passed in the original dissemination of the human race.

It must be said, however, that with the exception of some features which are common to all phases of human culture, and are the spontaneous outgrowth of qualities which are inherent in all peoples—or are the records of creeds or customs which prevailed in the cradle of the human race, wherever that be—there is nothing whatever to indicate a borrowing from Egypt or Tyre or any European nation. On the contrary, there are an originality and independence in all the forms in which this civilization was embodied that prove that it was either indigenous and grew from small beginnings in the country where it subsequently attained its full development, or was imported in its embryonic state from the Oriental Archipelago. There are some things which indicate that its germs were derived from the latter source. On Ascension and Easter Islands there are large structures of stone with huge columnar engraved monuments. Remains of similar character are reported from the Sandwich, Kingsmill, the Ladrones, Navigator's, and other islands of the Pacific; and it is evident that, in times so ancient that all memory of them is lost, a people inhabited these islands who had many of the arts of civilization, and who were essentially and characteristically workers in stone. The similarity of the works on these different islands indicates their progressive occupation by a people who were compelled, in passing from one to another of their stopping-places, to traverse as great a breadth of ocean as separates some of these from the American continent; and it is not improbable that the final resting-place of this people was upon the western coast of the great double continent, of which the continuous Cordilleras, like a great wall, arrested their eastward migration. Here they spread from their center of radiation to Chili on the south and to Utah on the north, elaborating in the course of time a civilization that was locally colored by the varying conditions of existence, but retaining enough of its original character to show that it was all an outgrowth from a common root.

If this was the history of our Mexican and Peruvian civilization, its original founders must have belonged to the same general stock with those who built the architectural monuments of India, and erected in the island of Java those wonderful temples now buried in the forests, and in ruins.

Still, the time of separation must have been so remote, and the culture of the period so low, that each form of civilization grew up independently of the others, and they now show little relationship.

It is the opinion of geologists that a great continent once occupied portions of the present areas of the Indian and Pacific Oceans—a continent to which they have given the name Lemuria—and it is speculated that this was the cradle of the human race. Be that as it may, from this section of the earth the brown Polynesians, Malays, Tahitans, Sandwich-Islanders, and Maoris spread, carrying with them characteristics and faculties which might very well be developed into a civilization such as that found on this continent by the European whites; and there is direct and collateral evidence that they sometimes landed on our shores.

Considering the balancing probabilities, I may say that it seems to be most probable that the west coast of America was colonized from that source, and that the development of great and cultivated nationalities was the result of ages of quiet residence in countries which favored by their climate and resources the special phase of development which we here find recorded.

As to the date of the planting of the first seeds of this civilization we can only say that it is lost in the obscurity of the past. Everything indicates that some of the monuments in the category we have reviewed are among the oldest records of the human race; and it is certain that the gradual growth and spread of this civilization, the long noonday of its maturity, and its progressive decadence—which began long before the advent of the Europeans—must be measured by thousands of years. Thus it will be seen that in antiquity this indigenous and peculiar American civilization takes rank with that of the Egyptians, Assyrians, Hindoos, and Chinese, and in respect to culture, numerical importance, and territorial area will bear comparison with either.

WHAT ARE DIATOMS?

By EMILY L. GREGORY,
OF BARNARD COLLEGE.

SINCE the microscope has become so familiar in our homes and ordinary places of resort, many terms are frequently heard which have an unfamiliar sound. For example, a lady asked the other day, with a laugh over the open confession of ignorance: "What are diatoms? I hear the word used very frequently, and with such an air of acquaintanceship and familiarity, that one must suppose they are the most common, every-day affairs, and yet I must confess I have never seen one and don't know really what they are."

Thinking possibly there might be others interested in a brief description of this curious plant, the following story is told of a visit paid this summer to a gentleman said to know *all* about diatoms. The plants in question are so small as to be seen only with the aid of the microscope; those of ordinary size, when magnified about three hundred and fifty diameters, appear about a quarter of an inch long. Others are much larger. They are curious little plants with a silica shell, which, in certain places, is provided with little apertures through which living parts of the plant protrude. In this way they are enabled to move about freely in the water by which they are generally surrounded, for, though they are not all strictly water plants, they all need considerable water to enable them to thrive, and so are always found in wet places.

Owing to their freedom of motion they were at one time supposed to be animals. Now it is known that they are plants, as they can perform all the functions of plants, and no animal, with all his superiority, high nature, etc., is able to do this. They are found everywhere in all inhabited countries, and in fact all over the seas, so it may be readily granted that a plant so common and wide-spread as this should be quite familiar to every one.

Again, not only are the living plants so wide-spread and common, but the shells of the dead ones remain intact for many years; and in certain localities these tiny shells are so numerous as to form a large portion of the soil. Some of the best known of these localities are the sites of Richmond, Va., and Berlin in Germany. It is often said that the city of Berlin rests on a foundation of

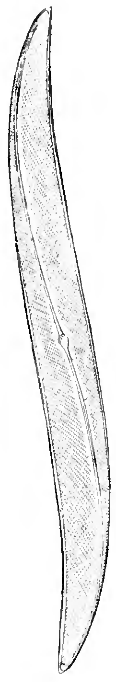

FIG. 1.—PLEUROSIGMA FORMOSUM.

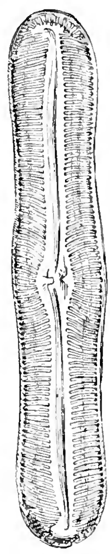

FIG. 2.—PINNULARIA MAJOR.

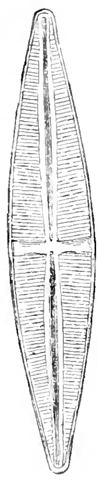

FIG. 3.—STAURONEIS PHŒNICENTERON.

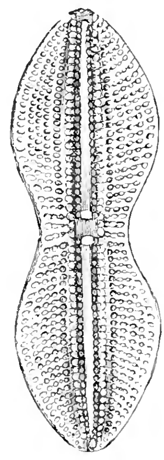

FIG. 4.—NAVICULA DIDYMA.

diatom shells. The little plant dies and decays, leaving the shell, which retains its shape for many years. These cells are most beautifully marked with very delicate tracery. No tools can be made to perform such work as this. Some shells with the most regular forms of markings are used for testing lenses, such as *Pleurosigma*, shown in Fig. 1. Some of the most common forms are represented by Figs. 2, 3, and 4, while another less frequent and with more curious markings is shown in Fig. 5.

Now, though it is so easy to obtain large numbers of these plants—only a spoonful of mud from the bank of a stream or edge of a pool, a bit of sea-weed thrown up on the shore will contain thousands of them and a great many different forms—though it is quite easy to find them almost everywhere, it is still very difficult to make out their manner of existence. For example, how they perform the feat of locomotion is not well understood. There are two ways of explaining this: one is, that the diatom moves from place to place, owing to the osmotic changes constantly taking place inside the shell; the other and perhaps better authenticated opinion is connected with the peculiarity already referred to—that is, the presence of little apertures in the wall through which portions of the protoplasmic contents protrude. Those who believe in the osmotic theory claim that no such apertures exist, and consequently no protoplasm finds its way to the outside of the shell. In connection with this point comes the story of the visit.

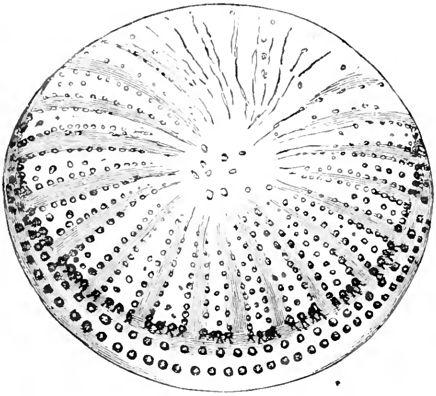

Fig. 5.—Stictodiscus Californicus.

While working in the Botanical Laboratory of Berlin this past summer, the writer was invited to visit a gentleman having the reputation of knowing more about diatoms than any other person now living. It is rather a strange fact that this gentleman is not a learned professor who has spent a long life over scientific problems, but a retired book-seller who owns a beautiful villa in the suburbs of Berlin, and has for many years been gathering information of various kinds about this wonderful little plant. He has nearly all the literature treating this subject, several large volumes of which are now out of print, and for which he told me he had been obliged to pay exorbitant prices.

Before proceeding to the inspection of the laboratories, specimens, models, etc., coffee and cakes were served in the garden, a distinctively German hospitality which no scientific interests are allowed to interfere with. We then began in the preparing laboratory, a small but very completely fitted room, where the material for investigation is stored, treated, and classified for use. Here are the chemicals used in preparing the plant for examination. Some processes serve to preserve the form and general structure of the living part within the shell, so that this may be studied; other reagents, on the contrary, destroy the living portion, whereby the shell may be more easily examined. In this laboratory was a microscope of somewhat older style than our recent ones, but a very good, reliable instrument, which he told me he used in the coarser manipulations, but, owing to the presence of chemicals in this room, none of his finer instruments were kept here. He explained his methods of treatment in clearing the soil and dirt from the land specimens, and also showed me the little silk nets which he uses when fishing for the water forms. Certain kinds grow only on the surface of the sea; so, to collect these, it is necessary to go out in a small boat and row very slowly, for the cloth of which the net is made must be very fine in order to prevent the escape of the tiny plants through its meshes. Owing to this extreme closeness of the meshes, the water drains through very slowly. The form of the net is quite like those used to catch butterflies, but is held with the handle up and close to the boat. At very short intervals of time it must be taken up and the water poured out; the inside of the cloth is then carefully rinsed in clear water, which is kept in a jar or bottle for that purpose. The most difficult part of the process is to row slowly and steadily enough to prevent tearing the nets.

These diatoms found on the surface of the water are furnished with long arms or projections, from which protrude hair-like bodies, which apparatus he conjectures is for the following purpose: One means of deciding that this little organism is a plant, is that it performs the function of assimilation, as it is called, by which it gives out oxygen. Now, this gentleman thinks the little hair-like outgrowths are for the purpose of holding the oxygen in their meshes so as to enable the plant to float.

FIG. 6.—LIVING DIATOMS: *a*, Cocconema lanceolatum; *b*, Bacillaria paradoxa; *c*, Gomphonema marinum; *d*, Diatoma hyalina.

After looking through this room and learning as much as possible about his methods of treatment, we went into another much larger and more elegantly furnished apartment, where all the nice and delicate work of studying forms and making models was done. Here were kept the books, all that have been written on this plant, and they filled a case of considerable size; also a very complete collection of microscopical apparatus. All that modern artisans can do in the way of fine and delicate instruments may be found here. Nothing less than the best oil-immersion lenses can be used in the study of form necessary to understand the inner structure of these plants. Several models have been made by this gentleman, and he told me of the hours of patient labor which it cost to bring out so much as one little turn of the inner canal whose windings hold the living and active part of the plant, and also the explanation of the manner in which it moves. He has studied the mechanism of several forms and made models of plaster of Paris, and others of wire. *Pinnularia major* (see Fig. 2) is the plant from which the most conclusive results were obtained, and he claims to have demonstrated the existence of apertures on the surface of the shell through which the protoplasm may protrude. He does not, however, claim to have actually seen the protoplasm on the outside of the shell, but holds that, according to other known facts, it must be forced out, though in very small quantities. These apertures do not open directly into the interior, but by a series of winding canals whose action prevents the too easy expulsion of the contents. The movement of this protoplasm along the lines between the openings causes the movement of the diatom in a similar manner to the action of the fins of fishes. All this labor, after all, has reference only to a certain class of these plants; there are many others of such different forms that much study will yet have to be expended on them before their secrets are laid bare.

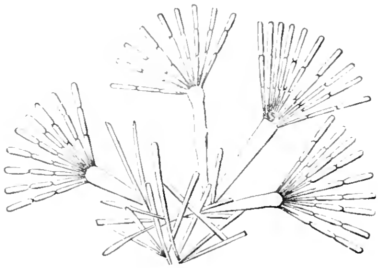

Fig. 7.—Echinella Flabellata, a fan-like marine diatom.

There are some curious little forms which grow in clusters on stem-like bodies which are often fastened by their other extremities to some object in the water. Some of these are shown in Figs. 6 and 7; and, finally, a variety of miscellaneous forms may be seen in Fig. 8.

There are large collections of these plants in nearly all the large herbaria of Europe, and the manner of preparing them for such collections may almost be said to form a special branch of industry. Experts are able to mount and arrange in order hundreds of these little organisms under a circular cover-glass of about five eighths of an inch in diameter. The dexterity which these experts acquire in the use of instruments is something almost as marvelous as the organisms themselves. It must be remembered, however, that this mechanical labor has nothing to do with the work of the scientist who studies the plant. It would be impossible for an investigator to give enough time to enable him to acquire this skill. A gentleman in Wedel, Holstein, has acquired a great reputation in this kind of work, and has plates holding from four to sixteen hundred different forms. These cost from twenty dollars upward, and he has recently finished a plate on which are mounted four thousand diatoms, with which there is a printed catalogue. This single plate is the result of four years of continued labor, and the price he fixes for it is twenty thousand marks, or about five thousand dollars. I inquired if there was any probability of the owner selling such an expensive collection, and he said very quickly: "Oh, yes! Some rich English or American gentleman will probably purchase it; no German ever will." According to some of the latest systematic

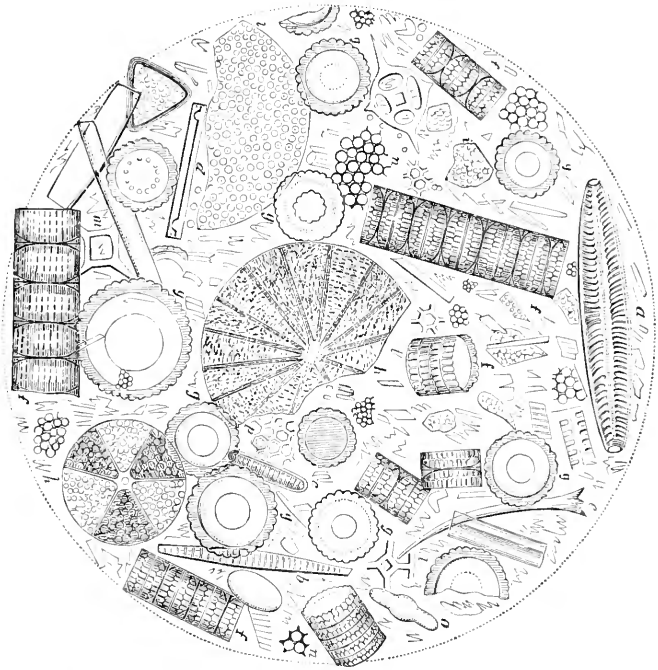

FIG. 8.—MICROSCOPIC VIEW OF RICHMOND INFUSORIAL EARTH. (By Ehrenberg.)

authorities, there are about eight thousand different species—so this plate may be considered as representing half of the known species.

It may be doubtful whether this story will help relieve the embarrassment of those who do not exactly understand what a diatom is. It serves to show, however, that very few people do know all about it; and this, together with the thought that it is considered of sufficient importance to warrant spending years of patient labor over it, will surely prove a consolation to those who have been puzzling over the meaning of the word.

THE RELATION OF BIOLOGY TO SOCIOLOGY.

By Dr. LEWIS G. JANES.

IN the preface to his recently published volume on Justice, Mr. Herbert Spencer newly emphasizes his conviction of the importance of the bearing of biological laws upon the study of sociological phenomena. Comparing the method of his present work with that of Social Statics, which covered a similar field of discussion, he asserts that "whereas, a biological origin for ethics was, in Social Statics, only indicated, such origin has now been definitely set forth; and the elaboration of its consequences has become a cardinal trait." The influence of this conviction is everywhere observable throughout the work.

It is not the purpose of the present writer, however, to discuss the applications which Mr. Spencer has made of this principle, except incidentally; but rather to reaffirm its importance, and to call attention to certain inferential dangers which spring from an unqualified acceptance of the conception that there is an entire identity of principle between the laws of social and organic growth.

While it is my firm conviction that Mr. Spencer has in no way exaggerated the importance of recognizing the bearing of biological principles in the study of societary evolution, it is equally important to guard at the outset against a fundamental though common misapplication of the analogy which would lead to results entirely divergent from the actual trend of social progress, as bearing upon the true scientific relations of the individual to the state.

On the one hand, it is undoubtedly true that nearly all our writers upon sociological, ethical, and economic topics are insufficiently grounded in a knowledge of the scientific method as revealed and illustrated in the physical and biological sciences. Their arguments rest largely upon an *a priori* and metaphysical basis of reasoning. They treat man as a being dissevered from the world. They fail to recognize the fact, demonstrated by the triumph of the doctrine of evolution, that man is one with the universe; that he can not be studied apart from his connection with the laws and principles which govern the physical world and the vital activities of the lower organisms. It may not be necessary for the sociologist, moralist, or political economist to be a complete master of physics and biology in all their branches —life is too short for such a preparation; but he should at least be sufficiently acquainted with these sciences to be thoroughly conversant with the scientific method of investigation, the tone and temper of mind requisite in the investigator, and have a general understanding of the laws and processes of biological growth as they are related to and distinguished from those exemplified in the evolution of inorganic structures.

On the other hand, theorists of the socialistic school have eagerly seized upon the assertion made by evolutionary writers that "society is an organism," and, by exaggerating the analogies between social and biological processes, have thence logically deduced their own doctrine of the supremacy of the state over the individual, claiming for it scientific and evolutionary sanction. Though Mr. Spencer has carefully guarded himself against this misapprehension, and his own philosophy of society is diametrically opposed to that of socialism, it is often claimed by writers of this school, and even by those who are of quite another way of thinking,* that it is only by a breach of logical sequence that he escapes socialistic conclusions.

Mr. Spencer, however, early noted the important fact that society differs from the higher products of biological evolution in that no social sensorium is discoverable; and in Justice he reaffirms and emphasizes this distinction in discussing the nature of the state. "The end to be achieved by society in its corporate capacity—that is, by the state," he declares, "is the welfare of its units; for the society having as an aggregate no sentiency, its preservation is a desideratum only as subserving individual sentiencies." He subsequently repeats this statement with renewed emphasis, evidently regarding it as of great importance.

In organic structures the unit or cell exists for the sake of the completed organism; its individual sentiency, if it possesses such a psychic quality, is subordinate to the sentiency of the organic whole. In society, however, the fact is the reverse: the social organism exists for the sake of the individual, or social unit. This relation of the individual to the social structure is one unquestionably which should be borne in mind and given its due weight in the application of biological analogies to the solution of the problems of society. Mr. Spencer's recognition of it completely absolves him from the logic of socialistic conclusions.

The resemblances between social and organic structures, however, are more notable and important than their differences, and are recognized not only by philosophical students of society, on the one hand, but also by eminent biologists on the other. Prof. Haeckel, speaking of the structure of animal tissues, says: "All the numerous tissues of the animal body, such as the entirely dissimilar tissues of the nerves, muscles, bones, outer skin, mucous skin, and other similar parts, are originally composed of cells; and the same is true of the various tissues of the vegetable body.

* Cf. Mr. George Gunton, in The Principles of Social Economics, pp. 298–310.

These cells . . . *are independent living beings, the citizens of the state,* which constitutes the entire multicellular organism." *

Again, he declares: "Every cell is an independent organism. . . . It performs all the essential functions which the entire organism accomplishes. Every one of these little beings grows and feeds itself independently. It assimilates juices from without, absorbing them from the surrounding fluid; the naked cells can even take up solid particles at any point of their surface, and therefore eat without using any mouth or stomach. Each separate cell is also able to reproduce itself and increase. The single cell is also able to move and creep about, if it has room for motion, and is not prevented by a solid covering; from its outer surface it sends forth and draws back again finger-like processes, thereby modifying its form. Finally, the young cell has feeling, and is more or less sensitive." †

Elsewhere, even more pointedly, he affirms, "The many-celled organism is ordered and constituted on the same principles as the civilized state, in which the several citizens have devoted themselves to various services directed toward common ends." ‡

Both biology and sociology treat of the phenomena of life; both involve psychological as well as merely physical conditions. In the natural order of the sciences the one leads up to the other by an inevitable sequence. There is a similarity in the processes of growth between biological and sociological structures which is noteworthy and most suggestive. Inorganic substances grow by simple accretion, or addition to their bulk. Their growth is involuntary, and is chiefly determined by the operation of external forces and conditions. Organic substances, on the contrary, grow by intussusception—a process of waste and repair initiated and carried on in the individual cells or structural units throughout the internal constitution of the organism; and their growth is mainly stimulated by internal, volitional effort. In this respect, as I have elsewhere argued, "the growth of societies resembles that of organic substances; it is a sort of vital chemistry." # The individual in his relation to society resembles the cell in its relation to the vegetal or animal organism. The death of individuals, and the birth and growth of others to fill their places in society, proceed in like manner with the processes of waste and repair in organic structures.

In the biological structure, however, the attractive forces which bind atoms into cells and cells into an organic unity are molecular and physical. In the sociological structure they are functional and psychical. And herein, I think, lies the explana-

* Evolution of Man, vol. i, p. 60. † Ibid., p. 131. ‡ Ibid., pp. 149, 150.

The Scope and Principles of the Evolution Philosophy, p. 22.

tion of that difference between these structures to which Mr. Spencer, Mr. Fiske, and others have called attention.*

As to the essential nature of those purely physical forces which we call attractive—e. g., gravitation, cohesion, and chemical affinity—we really know nothing. We know these forces only through their observed effects; and their "laws" which we deduce from repeated observations of these effects are merely our subjective classifications of orderly recurrent phenomena and their recognized conditions. In regard to sociological phenomena, however, we have an additional source of information. We can study the attractive forces which bind society together, not only in the secondary relation of their observed effects, but also in their primary relation, as movements of our own thought. Affection and self-interest are thus seen to be the attractive forces which bind society together, and these forces are consciously directed and made steadily operative solely by individual volition. Therefore it is that in its psychical aspect—the aspect directly involved in all measures of social advancement—society is subordinated to the individual, the structure to the unit, instead of the reverse, as in the evolution of animal and vegetal organisms.

All actual and permanent expansion and integration of society proceeds from the voluntary, co-operative action of individuals. The social reformer, therefore, who would work in harmony with the tendencies and laws of Nature must direct his efforts toward convincing the judgments and influencing the motives and moral natures of individual men and women, rather than toward forcibly changing the customs of society by legal enactments, official *pronunciamentos*, or majority votes under the white heat of an emotional political campaign. All of these popular and customary agencies of political action are doubtless of some service as educational influences, inciting thought among large classes of people who would otherwise remain passive puppets or unreflecting adherents of conventional social customs; but as means of finally solving and disposing of social and political problems they are lamentable failures.

It is strange that our socialistic reformers, who advocate the cure of societary ills by legislation and the paternal control of the Government over the affairs of the individual, do not see that men and women must first be personally convinced of the utility of such public arrangements as they advocate, with substantial unanimity, before legislation in their behalf could possibly be effective. And when the practical unity of sentiment has been wrought out in the community which would insure the enforce-

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* The Doctrine of Evolution: its Scope and Influence. Popular Science Monthly, September, 1891, p. 592. Notably, also, Mr. George Gunton, in his Principles of Social Economics.

ment of the law, the law is usually no longer necessary. In other words, *voluntary consent* is the essential condition of all stable social arrangements, instead of governmental coercion.

It may be objected that the social philosopher is compelled to recognize that, under the law of relativity, arbitrary and paternal forms of government have had and still have their proper place in the order of societary evolution. They are adapted to certain phases of culture and civilization, wherein order could not be maintained under freer and more democratic governmental institutions. This is true; but such forms of government are always temporary and unstable, where the conditions of social progress are steadily operative. As populations attain to a higher degree of intelligence and culture, a larger freedom is demanded; and no arbitrary government can long resist this popular demand. The result of such resistance, when it is attempted, if not revolution, is stagnation, atrophy, and arrested development.

This principle of voluntary consent is well illustrated in the earliest and most primitive type of societary development—the family. The family is based upon the marriage relation; and while, in the savage and barbarous stages of human evolution, we have marriage by capture and the exercise of various modes of coercion sanctioned by custom and authority, it is universally admitted in all highly civilized communities that true marriage rests upon the uncoerced consent of both contracting parties. As this consent is less a matter of mere formality and becomes more perfect and complete, involving the recognition of attractions not only emotional and physical, but also intellectual, moral, and spiritual, so is the union more permanent and satisfying.

The principle herein laid down holds good in every stage of social combination, however complex and widely extended it may be. It is a sound political philosophy which is enunciated in that paragraph of our Declaration of Independence which affirms that all just powers of government rest upon the consent of the governed. This is as true of the older autocratic and monarchical systems as it is of our own democratic-republican form of government. An autocracy which finds no response in the hearts of the people, but is maintained solely by the iron rule of external compulsion, is a tyranny, unstable in its foundations, unadapted to its societary environment, and destined to early destruction, either by peaceful evolutionary measures or by forceful revolution. In such a state, nihilism and anarchism are natural products of the existing social conditions. The pent-up forces of an artificially restrained individualism must somehow find vent, even if it be by means of revolutionary violence. Russia to-day offers an instructive example of the truth of this principle.

The object of the social reformer should be, not only to accomplish the renovation of society, but to do it in the quickest possible time in which it can be so accomplished that the changes effected shall be permanent, and the trend of social evolution shall surely be directed toward the ideal end of individual enlightenment and liberation and social integration. These ends can be surely accomplished by the method of evolution; they are as surely retarded and indefinitely postponed by the methods of anarchical violence and artificial compulsion. The individualism fostered and aimed at by the evolutionary method should be sharply distinguished from that destructive anarchism which aims at the sudden and forceful abolishment of existing institutions.

Here, too, biology offers us a wise suggestion. Galton's law of "reversion toward mediocrity" shows that those biological changes which are suddenly effected by artificial selection and forcible deviation from the main trend of natural evolutionary tendency are not permanent. They endure only so long as the organisms are kept under the direct and active influence of the artificial conditions which produced them. The moment they are left to the unrestrained operation of purely natural forces, they speedily revert to their original status. This must be the case in sociological evolution also, whenever social and institutional conditions are artificially forced, in advance of the intellectual culture and functional development of the masses of the people.

The history of our own time is full of instructive examples illustrative of this sociological law: of innumerable co-operative experiments, ideal communities, and the like, that have arisen, obedient to philanthropic impulse, enjoyed a brief, precarious existence, and died for want of sustenance; of artificial commercial situations, the product of legislative interference with the natural laws of trade, which induce at first a feverish appearance of prosperity, followed by great fluctuations in values, and finally by panic and financial collapse. As artificial conditions thus established are always liable to be suddenly modified or annulled by variations in popular sentiment, the progress of discovery and invention, changes in governmental administration and administrative policy, the influx of foreign elements into the population of a given locality, and a thousand and one other causes, temporarily or permanently operating, it should manifestly be the purpose of the wise social reformer *to build along the great lines of natural evolutionary tendency,* and thus to make use of those elemental forces, social, moral, and biological, which will insure stability and permanent prosperity for the results of his efforts.

He will thus aim to encourage voluntary co-operation instead of an enforced regulation of society by means of legislative enactments. The success of this aim will, of course, depend upon the intelligence and moral development of the citizens of a given community. The liberation of the individual—his increasing ability to secure the satisfactions consequent upon the free and orderly use of all his faculties—will proceed *pari passu* with his increasing dependence on the co-operative labors of his fellows. The processes of social differentiation go on hand in hand with the tendencies to social integration. As occupations become more diversified, the individual acquires greater skill in his special vocation; he produces a greater amount of wealth, and thus conduces more to the well-being of society, as well as, under a properly regulated system of labor, to his own personal well-being. Fewer hours of labor are requisite to insure a livelihood, as labor becomes differentiated and automatic; more time may be bestowed upon general culture, social intercourse, and the service of the commonwealth—upon the development, in short, of that fullness of life which constitutes the ideal of a perfect manhood.

In wisely serving himself, the individual is thus rendering a greater service to society; and this, in turn, inures to his own roundabout development. Egoism is thus purged of its excesses, and made to promote the general well-being. This, in turn, conduces to the highest individual prosperity and culture. In the proper equilibration of egoistic and altruistic motives in the government of conduct, all conflict between these motives ceases. In wisely serving his neighbor man renders the truest service to himself, and *vice versa*. Thus society integrates by a natural process of growth, obedient to laws which are operative in the evolution of all living things; and its ultimate form constitutes a real brotherhood of consent, instead of a militant organization consolidated by external coercion.

WANTED—A RAILWAY COURT OF LAST RESORT.

By APPLETON MORGAN.

WHILE the debates in Congress which resulted in the passage of the act to regulate interstate commerce were in progress, and during the first few months of the enforcement and interpretation of that act, I contributed to The Popular Science Monthly a series of criticisms of that act and of its policy.

To me, and to thousands of others, the policy of the act seemed un-American and paternal; or, if not un-American and paternal, then a policy which could and should be applied to other than the transportation industry—to places of public amusement, or to professional pursuits, to the business of the physician or the lawyer, or to hundreds of others. I pointed out that, if rigidly enforced, the act would amount to a confiscation of private property; since, if the investment of private capital in any business can be compelled to make charges for services in accordance with a tariff not framed with any reference to the capital invested or the value of the service rendered; or if the value of services can be estimated by the person served, and paid for only in accordance with his estimate, and without hearing from the party performing the service, the value of private property invested in plants used to render services to others than its owner would speedily disappear. In other words, the principle upon which the Interstate Commerce Act appeared to me to proceed was one which, if pronounced proper, would justify—and if rigidly enforced might even result in—the operation of all railways by the Government. But, however that policy might work in European countries, it seemed to me impossible of other than despotic and ruinous application in the United States with its five hundred railways, their vast united capital and their enormous aggregate of fixed indebtedness held in the shape of negotiable securities, and very largely held in England and upon the European continent. At least it seemed to me impossible without a peremptory, and so a paternal, fixing of values at which the Government should acquire the railway road-beds and plants, not to mention the creation of a tremendous civil list, which in itself would probably precipitate the very evils and tyrannies which the socialists and alarmists foresaw from the private ownership of railways, and the consequent accumulation of occasional private fortunes beyond the actual appreciation of services of the employments of capital.

The Interstate Commerce Act has now been in operation about four years. Its enforcement, so far from being rigid, has been marked by extreme leniency and enlightened judgment upon the part of the commission appointed to administer it—a judgment in which the echoes of public clamor or the verdicts of the marketplace have found no recognition; and the result has been, it seems to me, an entirely unforeseen situation—one still more favorable to the railway companies and charitable to their procedure, if possible, than was the situation prior to the enactment of any Interstate Commerce law whatever. Before proceeding to demonstrate a few of the anomalies of this, from my own standpoint, entirely satisfactory condition of affairs, it is only fair to the railway companies to state that they, immediately upon the appointment of the commission, began to enforce the most implicit obedience to the letter of the Interstate Commerce law, and that —whatever diplomacy there may have been on their part—it has never resulted in the administration in a single case of the penal processes with which the commission was empowered by the act to, in its judgment, follow up a recalcitrant railway company.

The inventors of the act of Interstate Commerce designed it to cheapen freights to the people by compelling railways to sharply compete, and to relieve the country from what were claimed to be discriminations, and to adjust local inequalities. They put the act upon the statute-book. But—by a strange deliverance of affairs—none of these objects were accomplished. No sooner did the act become law than it operated to relieve the railways from competition, increased freights, and shifted, without lifting or adjusting, what were called "discriminations." But, while powerless to advance the objects for which its projectors had fondly drafted and urged it, the act did accomplish one great good—and one not local, as were the grievances, if any, it was framed to remedy, but a national and general good, which it is needless to say its framers and proponents never dreamed of subserving. That national good was nothing less than the appreciating of American railway securities in the European exchanges.

I am not exactly certain that the railway companies themselves foresaw this result when they yielded so prompt and unanimous an obedience to the Interstate Commerce Act, but it is indisputable that this acquiescence and obedience brought about this happy desideratum. It has not been unsuspected that, just as the past few years have seen the "Trust" devised by capital to meet and offset and checkmate the waste and unreasonableness of the labor-unions, so the railway companies, upon finding the popular opposition to them crystallizing into a Federal statute, by a single *coup* turned the statute itself into an ægis, and made it (as the old maxim says of the device of a mortgage) a shield as well as a sword. But, however this may have been, the immediate result was as I have said. The European investor, who had often looked askance at American railway securities, because he had somehow absorbed a notion that our United States railway companies were more or less unregulated by statute, and so more or less lawless, upon seeing them brought under Federal regulation (always with his old-time ideas of the paternal and constabulary benefits of government control), did not hesitate to bestow upon our railway securities the confidence with which he already regarded our Government securities. As I have said, it is an open question whether the railroad companies themselves foresaw this result; but it remains another and a very curious cumulative instance of how (as I have before noted) the Interstate Commerce Act worked upon the railway companies, much as the prophet Baalam is related to have worked upon the children of Israel. He was employed to curse them, but he blessed them superlatively.

But if the policy of Federal regulation of railroads is to be permanent, it should be as perfect in operation and as nicely adjusted as possible; and to this end there are two details still desirable. In order that the subjects of the regulation, as well as its administrators, should be able to know exactly what is required of them: exactly what to expect, and be forever—the one as well as the other—confident that no rules and regulations, penalties or punishments, should be at any time "sprung" upon them, or be enforced by way of surprise; or without, as the phrase goes, that due process of law, "of which" notice "has been held to be the most essential part": it is necessary and vital that there should somewhere be and remain a court of last resort.

Now, the tribunal or office which we know as the "Interstate Commerce Commission"—with headquarters in Washington—is not a court of last resort, or, indeed, a court of any sort. It is nothing, indeed, but a referee or master-in-chancery, whose only authority is to find and report a fact or a state of facts. (This has been repeatedly held, not only by the lower courts, but by the Federal Supreme Court itself.) Moreover, this Interstate Commerce Commission has no power to award a judgment; or, if it does award a judgment, to enforce that judgment by process or execution. However penal in character its decrees may be, the summary process must issue elsewhere.

Assuming that the American principle that all government derives its charter from the consent of the governed has been satisfied by the obedience rendered to the provisions of the Interstate Commerce law by the railway companies, it follows that the railway companies are entitled not only to know exactly what is expected of them, but to know to what tribunals they are amenable in case of any future disobedience or inadvertence or misunderstanding as to the provisions or edicts by which they are governed. And, further, the governed are entitled to a single statute or set of statutes, and to a single tribunal or succession of tribunals, and to be relieved from the confusion of conflicting collateral statutes and collateral tribunals. If they, the governed railway companies, are not entitled to know just exactly what they are to do and what to leave undone, then they are entitled to the public sympathy rather than to the public surveillance; and, no matter what they do or leave undone, can plead such a conflict of collatera laws and of decisions and of decrees of courts as will leave it impossible for them to be guided by anything—in any given case—but their own sovereign discretion.

Is there at present such a state of affairs as renders the railways entitled to act upon their own sovereign discretion, equitably if not legally; and to plead mistake in case of an arraignment for any consequences or any result of such action? Remembering that the law of the land, the common law, was not written for railway companies, who are only persons (or at the most common carriers in the eye of the common law), certainly they are entitled as persons that statutes passed to regulate them as railway companies should be definite, fixed, single, and certain. It is as abhorrent to justice that a corporation, or a railway corporation, as it is that a natural person, should be compelled by law to act at his peril. But the situation is exactly this: Anomalous and intolerable and abhorrent to justice as it may appear, our United States railway companies are compelled by law to act at their peril. For every single one of our forty-four sovereign States, and about all of the Territories, have copious and dictatory statutes concerning railways, and these statutes are in every case to be added to—not held appealable to or reconcilable with, but collaterally additional to—the Act of Interstate Commerce! And each governed and regulated railway company must either select some course of procedure which shall contain some three or four, some larger or smaller, groups of these State and Federal statutes, or else disobey one or more groups of them at its peril; or in almost every possible case presented to it for its discretion institute suit for a construction of all these statutes in each particular case, and carry it to the court of highest resort, the Supreme Court of the United States! Indeed it is only, as I have said, because the Interstate Commerce Commission has thus far been composed of gentlemen and jurists who have used the utmost personal judgment, conservatism, and leniency in administering the statute, that every railway company in the land has not been driven to one or the other of these procedures (and this not once but hundreds or thousands of times, almost daily, in fact), viz., either to flatly disobey, or else to maintain a suit up to the Supreme Court of the United States. But from the calmness and conservatism of a tribunal as once, at present or at any one time constituted, unhappily no warrant for the future or for any other time can be drawn. A change of *personnel*, always possible, might ingraft or enforce a new policy at a moment's notice, with what results nobody could predicate or prophesy. But one can always state that, in whatever form the result came, it would amount to an interruption of public business and of the course of commerce.

Now, there are two remedies for this state of things: one of which has been urged before, and by a no means inconsiderable or thoughtless or turbulent or revolutionary element of the population; and the other of which has been certainly suggested, though not, as I am aware, ever very seriously discussed. The first remedy is the purchase and operation of the railways by the Government; and the second is either the abolition of State railway statutes and of State Boards of Railway Commissioners, or else the making of the Federal Board of Interstate Commerce an appellate court from the court of the State Railway Commissioners, thus either subordinating or conforming all State railway statutes to the Federal statute of Interstate Commerce, amending the railway statutes to the statute of Interstate Commerce in as far and as often as the same may be amended or altered or enlarged by the Federal Congress.

The first of these remedies—the Government purchase and operation of railways—I have so fully and at length discussed in these pages that it would seem superfluous to touch the matter further, unless the reasons then given to show that the project was impracticable and impossible (or, if practicable and possible, then unconstitutional) can be disposed of. I may briefly state that the principal of those reasons were: first, that the immense number of competing railways would make the operation of more than one of them between terminals an act of bankruptcy on the part of the Government (which would attempt to compete with itself), while to discontinue a competing road would be to deprive local stations of business facilities to which they would be entitled as well as the terminals; and, secondly, as above stated, that to operate the five hundred railways in the United States, or any considerable number of them, would necessitate a civil service so enormous and costly that, even if administered with the most rigid economy, it would absolutely and superlatively realize for this people the worst effects which the most hectic of the popular railway reformers have prophesied from the continuance of the present system. In addition to these practical objections the constitutional objection was, that the purchase of our railways would be impossible at present, whatever it might have once been, since no price at which the railway plants could be purchased could be arrived at. To purchase them at more than their value would be a robbery of the non-railway public; to purchase them at less than their value would be a robbery of the owners of the railways; while to purchase them at their exact value, admitting that it could be reckoned, would be in itself a confiscation (and so a robbery), as forcing innocent holders to relinquish such legitimate investments for their capital as they had lawfully seen fit to select.

As to the second remedy, there is, I think, something—indeed, a great deal—to be said in its favor, not only from the side of the railway companies, but from the side of the people of this country (from the shippers, as we may perhaps call the non-railroad operating population; of course, an enormous majority of the whole). And as to this I respectfully offer the following considerations, not in behalf of the railways, but of the customers of the railways.

Congress has more than once passed a national bankruptcy act, and, I believe, always with beneficial results. Moreover, I think no sooner has a national bankruptcy act expired or been repealed, and the various State insolvency laws more or less taken its place, than the public credit has felt the change unfavorably, and the business interests of the community have clamored for the re-enactment or rehabilitation of the national statute. Now, if the Interstate Commerce Act stood alone, both the railway companies and the people would know exactly what was expected of each, independently and reciprocally. A codification of the procedure thereunder would place the whole simply at everybody's hand. The railway company would have no excuse for disobedience, and the aggrieved shipper would have not only his grievance but his remedy at his tongue's end. And not only would the shipper have a right to prosecute the company for disobedience or inadvertence or neglect or mistake, but the railway company might proceed against a recalcitrant shipper to compel him to obey the law: and this to the benefit not only of the railway company, but of his co-shipper or neighbor, to the quieting of all possible railway "discrimination."

If it is necessary in the present paper to demonstrate that as the Federal law stands, and as all these State and Territorial laws stand, neither of the great interests involved, neither the people nor the railways, can know where they stand, either independently or reciprocally, the demonstration is easily forthcoming.

To outline it as briefly as possible: At the appearance upon our statute-books of the act of Interstate Commerce, the art of railroading, in spite of all and singular the State statutes (some of them absolutely ridiculous, more of them unconstitutional, arbitrary, and penal, and almost prohibitive, and almost all of them inequitable to a large degree, as my prior papers have perhaps demonstrated), was rapidly approaching the state of an exact science. But, by the appearance of that act, this art or science of railroading was arrested and thrown back upon itself in a sort of "chaos by act of Congress." The enormous fixed or mortgage debts of the American railways—a large, perhaps the largest part of which was held in Europe (where, to a degree almost impossible to adequately describe to one not familiar with these matters, it involved the national credit itself)—had rendered the pooling system imperative. This pooling system had not been "sprung" by the railways upon the people, nor was it for the benefit of higher rates, or in the nature of a combination against trade, or of a "Trust." On the contrary, it had been evolved slowly—by long and costly experiments, and by extended deliberation on the part of the railway companies, and had expedited an absolute cheapening of freights, and a consequent impetus to manufactures, the reclamation of waste lands to agricultural purposes, and so had resulted in an unexampled—and promised a still more enlarged—prosperity. Not only was it found impossible for the moment to equate rates, or to know what to charge the public for railway service, but among the railway companies themselves it was impossible to contract or hold each other to their agreements, covenants, or mutual obligations. Moreover, every or any insignificant local railway in the land (of five or ten miles long, or even of less) might and did solicit and accept freight to any point in the United States, Canada, or Mexico at arbitrary rates—deliver the freight at the end of its haul to other, and this to yet other, lines—so finally forwarding that freight to its destination at a rate absolutely prohibitive to a trunk line extending directly from the shipping to the destinative point of that very freight; and this from motives, not of competition, but of, say, jealousy, or looking to the depreciation of securities, and so of ultimate absorption, or control, or "wrecking" of the trunk line. Into this confusion stepped the State railway boards, each lending a hand, until for a time it seemed as if the business of railroading was about the most undesirable and unprofitable of employments not only, but a sort of punishment in itself. In short, it was as a last gasp, or a forlorn hope, that the railway companies, to save themselves, invented "pools," and begged acquiescence in them of the short local lines —in the hope of being able to earn their operating expenses, and possibly a prophetic fraction of their fixed charges. Imagine their consternation at an act of Congress which appeared and prohibited pooling!

What the railway companies or the national credit would have done, had it not been for the first important decision of the Interstate Commerce Commission (known as the Louisville and Nashville decision), it is impossible to conjecture. That decision, coming at the right time, declared that, while the text of the act forbade "pools" or "discriminations," or "the charging more for a short than a long haul," the spirit of the act was to do the railway companies as well as the shippers justice under the circumstances of each case. In short, that circumstances must control.

Under, I say, that benign decision, the railways have been able to exist and to prosper and pay their fixed charges. The "Gentlemen's Agreement"—nothing more or less than a series of "pools," called "associations"—only created by a sort of national instead of local consent (that is, by the principal railways acting as a unit instead of by groups of railways here and there—grouped by local or competitive considerations), has enabled the interest on American railway securities to be met abroad, and so the national credit maintained in the sensitive European markets, and all for the time has been well. The expense, to be sure, has been borne by the people—the shippers. There has been a uniform advance in freights. But this advance the people have felt was a small enough price to pay for the principle of Federal control of railways; and, as I say, the railway companies have acquiesced.

But, while the situation is just at present satisfactory, and while the railway companies, up to the present time, have been able to "pull through," it is impossible to deny that there is cause for considerable uneasiness, and indeed for considerable positive alarm, in the railway situation. It can not be too often repeated that the enormous mortgage debt of our five hundred American railway companies, averaging some fifteen thousand dollars per mile for some 200,000 miles of railway, being largely held abroad and payable in gold, most intricately and indissolubly controls our national credit. It must not be for a moment forgotten that the payment of the interest on this vast debt or loan is dependent upon the earnings of all this mileage, and that, if the shipper can not pay what the railway earns, this interest can not be paid. It is for these reasons that the subject of a conflicting Federal and State supervision of railways, and of their relations with the people, is of popular interest, and deserves discussion in The Popular Science Monthly, instead of being treated only in financial articles, which only reach the banker, the investor, and the capitalist. Nay, more, the direct interest of the people in the question of a collateral and possibly conflicting State and Federal jurisdiction over railway companies is even more immediate than as above outlined. Indeed, this direct popular interest can be traced into so many channels, each one of them ramifying into so many more, that one quite despairs of exhausting them within the limits of a single paper. Some of the more important of these channels may be, however, briefly indicated:

First, it is directly to the public interest: to the interest of each individual, capitalist, investor, or professional or working man, bread-winner or consumer: that values should fluctuate as little as possible, which is only another way of saying that capital should always be able to find remunerative investment. But (as shown before in these pages) if the capital now locked up in railways is not a remunerative investment, the next step is the railway bankruptcy, the stock-"waterer," and the railway-wrecker. Admitting, then, that the enormous fortunes, the accumulations of vast resources in the hands of one or two individuals—which was the constant argument of our Mr. Hudson and his ilk, and always is and always will be the argument of the communist and the anarchist—comes from stock-watering and railway-wrecking, it is the direct popular interest that our railway companies should earn their fixed charges. And to earn their fixed charges they must first, as we have said, earn their operating expenses: and to earn these, or either of these, they must first of all be left in peace, and not at their peril to lawfully do all lawful business which comes to them.

A second ramification of this question of conflicting Federal and State laws may seem at first far-fetched, but on examination it will, I think, be found to be very intricately connected with the public interest. In the President's last message to Congress his Excellency says:

"I have twice before urgently called the attention of Congress to the necessity of legislation for the protection of the lives of railroad employés, but nothing has yet been done. During the year ending June 30, 1890, 369 brakemen were killed and 7,841 maimed while engaged in coupling cars. The total number of railroad employés killed during the year was 2,451, and the number injured, 22,390. This is a cruel and largely a needless sacrifice. The Government is spending nearly one million dollars annually to save the lives of shipwrecked seamen; every steam-vessel is rigidly inspected and required to adopt the most approved safety appliances. All this is good; but how shall we excuse the lack of interest and effort in behalf of this army of brave young men, who, in our land commerce, are being sacrificed every year by the continued use of antiquated and dangerous appliances? A law requiring of every railroad engaged in interstate commerce the equipment each year of a given per cent of its freight-cars with automatic couplers and air-brakes would compel an agreement between the roads as to the kind of brakes and couplers to be used, and would very soon and very greatly reduce the present fearful death-rate among railroad employés."

It seems to me that this passage brings us exactly to the question before us, for, while the President's recommendation is on the side of humanity, it is possible to see how considerable inequality and injustice might result from a carrying out of the suggestion. Even humanitarian laws are not always laws for the greatest good of the greatest number. For example, it might be asked, Why interstate railways only? (of course, in a message to Congress only interstate railways could be mentioned, as under its jurisdiction, though this is only true in a measure and not, as I take it, necessarily so)—and, if interstate railways only, how if State laws should also provide for the use of an automatic coupler, and supposing a State law should decree the use of one kind and the Federal law decree the use of another? Before the railway company could ask for a reconciliation of the two decrees, or even in good faith endeavor to provide an equivalent, how many litigants might arise to sue for a penalty under one law or the other, or how many railway accidents be added to the fatality list? And let it not be forgotten that, strange as it may appear, the enforcement of the President's suggestion would actually work a hardship to the employés themselves by throwing thousands of them out of employment. (Of course, the hoary old question as to whether improvements in machinery in the long run do actually throw laborers out of employment might be discussed just here, but I fancy that while we were discussing it a great many brakemen might starve.)

If such a matter as this could be left by all the States, by unanimous consent, to the Federal power, and if, instead of so sweeping a law as the President suggests, a statute might be provided requiring the draw-heads of all freight-cars manufactured or admitted into the United States to be of a uniform height and to be within projecting frame corners from the rail surface, everybody can see that not only humanity but perfect justice both to the railway company and to the employé would be subserved.*

We are not at present discussing the question of automatic couplers; but this illustration shows: first, the necessity of a single and uniform railway law-maker, and that the law-maker should be guided only by expert knowledge and act only after adequate discussion and deliberation as to the best methods for not only preserving the lives of employés, but of conserving to them the opportunity of earning a living, and to the railway company the opportunity to earn the money to pay them their wages. It is certainly not necessary to go further into the subject already so fully discussed in these pages; but when the reader of former papers remembers the absurd and arbitrary laws passed by certain State Legislatures, such as prescribing the size and cost of station-houses, the number and distance even, without the slightest regard to the business or the earnings of the company, he will see at once how prohibitive of profitable railway enterprises (and so how perilous to the public, and even to the national prosperity) it may be, to leave all statutory control and regulation of railways in its present indifferent, undecided, and altogether chaotic state. It seems to me that it is the interest of the nation, of the public at large, of the railway companies, of their employés—in short, of all concerned—that such an adjustment may be arrived at as will secure, if at all, a Federal control of railways in the spirit of

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* I think such a law as this would be a better one than one directing the use of an automatic coupler, for it would not throw any brakemen out of their jobs. As to the loss of life spoken of by the President, the larger number of instances will, I think, be found to have occurred at night, when brakemen, not knowing of course the height of the draw-heads of the cars approaching them, and often while using every precaution, might be caught and crushed by a different build of car with flush corners, or higher or lower timbered corners. Such a law, prescribing uniformity in this detail, and mulcting the company owning the car or cars causing the death or mutilation with adequate damages, would be, I think, a salutary and an exemplary one.

the present Act of Interstate Commerce, by making that act superior to and controlling all State laws: at any rate, some single tribunal whose decisions may make a body of railway law for the protection as well as for the discipline of railway companies. If a possible dissenting voice should urge that there was a difference between a "State" and an "interstate" railway, I may add that it has been held repeatedly by the Interstate Commerce Commission, and never denied by the courts, that a railroad which is wholly within a single State, if engaged in the transportation of passengers and freight going to or coming from another State, is engaged in interstate commerce and is therefore subject to congressional control; and the Commission have repeatedly asserted, and are in this upheld by the highest authority,* that Congress may with respect to all the subjects of foreign and interstate commerce, the power engaged in, and the instruments by which it is carried on. It gives the power to prescribe the rules by which it shall be governed and the conditions upon which it shall be conducted. It embraces within its control all the instrumentalities by which that commerce may be carried on, and the means by which it may be aided and encouraged; and, if I am not in error, this power has been extended, by the present Interstate Commerce Commission, to the regulations and the workings and maintenance of a bridge over which freight having an interstate destination is transported! With such an interpretation of the constitutional clause, it would not seem to be going too far if the Commission should assume a veto power over the State Commissioners; and I am sure it would not be difficult to use it with the highest possible regard for the interests of all concerned.

One of the jurisdictions proposed for such a tribunal of railway last resort as I have suggested is that of restricting the construction of proposed railway lines by decreeing whether or not a proposed railway line is necessary or desirable between two given points. I think it is entirely safe to say, however, that no such jurisdiction will ever be assumed, or, if assumed, will ever be exercised by any tribunal or court within the United States. This people would resent (and no class of it sooner than that of men of the Hudson caliber, who see in railways the approaching cataclysm of the nation), as intolerable, the idea of any arbitrator—however lofty—deciding upon an individual's right to invest his own capital entirely as seemed to him good; but principally because such a power, if granted, would not be confined to a negative action alone. The right to forbid the building of a railway between two certain points would lead up to, and in time arrogate, the right

* 93 U. S., 103–114. Id., 196.

to decree the building of another railway between two other points; and as the one would be impossible, so the other would be absurd.

For all that is said about superfluous and over-railway construction, I confess that I would like to hear mentioned the one of our five hundred United States railway lines which is superfluous, or which the community which is served by it would consent to have torn up or to otherwise dispense with. I have myself cajoled, argued, and fought for rights of way, and finally brought condemnation and sundry other legal proceedings in order to construct a railway; but, once constructed, I think it would be dangerous to limb or life to suggest a discontinuance of that railway to the very people who once resisted, to their last extremity, its location.

The people of the United States are indebted to their railways in a sense which obtains in no other country on this planet. To say that the railways have turned forests into farms and made the desert blossom as the rose does not express this obligation. It is a greater one than that. To the United States as to no other nation the railways have brought wealth by a present realization of prospective revenues so enormously as to quite amount to an actual creation of values. In other countries railways have been built when populations demanded them, or could not exist longer without them—when great cities were to be brought together and great industries to be served. In the United States the railways have preceded and created the demand, the interests, the cities themselves.

The percentage in error of judgment is at least no greater in the promoting of railway enterprises than in any other branch of human procedure. Nor is it impossible to argue that even a forced railway construction—where actually no demand can be premised, no interests subserved, where no capital seeks legitimate investment, and no traffic exists, and for only ulterior purposes (such as "selling out")—is entirely a disadvantage to a community. Even the debentures of such a railway are not a public burden. For, while a promise to pay value is not perhaps a creation of value at the start, if interest be paid upon that promise and it is finally funded and ultimately paid in cash, it becomes a contribution to the public wealth (however meanwhile that promise or the guarantee of it may work criticism or prophecy of national ruin, or the elocution of the agitator or the communist about bloated or unhealthy private fortunes and the like). Large views and considerations of "the long run," do not, I think, warrant any paternal surveillance over private capital or the laws of supply and demand. What is wanted is either a surcease of railway commissions, Federal, State, and Territorial, in the United States, or else that those tribunals which do exist be created into an intelligible succession, with one of last resort at the top, whose decrees shall be final to protect, as well as to discipline, both the railway company and its customers.

PESTIFEROUS PLANTS.

By Prof. BYRON D. HALSTED,
BOTANIST OF NEW JERSEY AGRICULTURAL COLLEGE EXPERIMENT STATION.

SOME plants, naturally, are better fitted to subserve the wants of man than others, and for the growth of these he puts forth special effort; in short, the whole underlying foundation of modern agriculture rests upon methods of favoring these plants and thereby enlarging and multiplying those qualities in them that led to their being chosen by man as objects of cultural attention. All plants, therefore, that now legitimately occupy space in our fields, orchards, and gardens are living an unnatural life, because they are in part creatures of selection and care; and it therefore follows that, owing to this stimulus under which they have flourished for generations, when the fostering hand of man is withheld they either perish or gradually drift back to the wild state and slowly lose many of their most valuable qualities as cultivated plants and regain those that better fit them for the stern battle of life. During the time while cultivated plants have been brought to a high plane of usefulness there have been many other species with no merit in their products that have stood in the way of the development of these fostered plants. The weeds have grown strong because obliged to fight their way and take every possible advantage when opportunity offers. They quickly win in the race for supremacy in every field devoted to cultivated crops, when man's care is withheld, and multiply their kind to an extraordinary extent. More reasonable it would be to expect a man under the softening influences of civilized life to win in the rough race for existence when placed, unaided, among savage Indians, than to hope for the success of a parsnip or onion seedling when surrounded by a rank growth of weeds.

There is nothing in the structure of a plant that Cain-like curses it forever. No part of the leaf, stem, fruit, or flower gives conclusive evidence that it belongs to a weed, and therefore we are forced back to the definition that was accepted a long time ago, namely, "A weed is a plant out of place." Its relation to others makes a plant a weed. A rose bush of the rarest variety, and one highly prized in its proper place, is a weed when occupying the soil to the detriment of some other plant that has the authorized right to the soil. Clover and the best of grasses may be serious weeds, fit subjects to be uprooted by the cultivator or hoe, when growing in a corn-field and injuring the maize crop. If a field is devoted to wheat, it follows that all other plants therein may be weeds, whether it be cockle, red-root, or an oak tree.

There is a possibility of any kind of a plant being a weed, but this thought does not prevent some species always being out of place. For example, there is no function in the economy of the farm garden that the Canada thistle can do as well as many other plants. As a forage plant, or a source of nutritious seeds or beautiful flowers, the pig-weeds are a substantial failure, equaled only by their success in occupying the soil and robbing it of nourishment designed for useful plants. It would puzzle any one to find a proper place for the horse-nettle, now advancing upon the Eastern farmers from the Southwest, and destined to spread its horrid, prickly, worse than worthless branches over our cultured soil. The bur-grass, cockle-burs, burdock, and a long list of congeners are practically universal every-day curses from which all earnest crop-growers wish to be free.

The natural covering of a fertile soil is a growth of vegetation. Upon the broad, open prairie there is a dense coat of grass, while in the Eastern States a heavy growth of trees clothed the virgin soil. So strong is Nature's desire to assert this right that if we allow one of our fields to lie fallow, at the end of the season it will be covered with vegetation. She understands that a bare soil is a wasteful soil, for while it is not producing anything it may lose by leaching much fertility already in its bosom. Every generation of plants inherits the deposits of all previous generations, and in turn should add to the accumulated stock in the soil. By this economical and saving practice of Nature the fertile newly broken grass lands have been made, while the upper soil in the forest has received the enriching accumulations of ages. Man overturns this harmonious system, and by breaking up the sod destroys the very method by which sod is made. He clears away the forest and many of the conditions which favor the growth of trees. It is upon this newly exposed soil that weeds assert their supremacy, and if the hand of man is withheld they will soon weave a garment, in itself unattractive, that clothes the bare earth. Weeds have a thousand ways of doing this to one possessed by cultivated plants. Bring up, if you please, some soil from the bottom of a newly dug well, and if exposed for a season some weeds will have planted colonies upon the bare heaps and vied with each other for the entire possession of the new territory, at the same time gaining in forces for the occupation of any similar place elsewhere.

The crop-grower necessarily introduces the condition of a bare soil for a portion of the year for every crop, and must therefore accept the situation: while he invites their presence and development, even stimulating them in various ways by making the conditions favorable for the growth of his crop plant, he must become a competitor with the weeds for the possession of the soil. The weed seeds are either in the soil or soon find an abundant entrance, and if the way is clear the young pests are up and doing as with the morning sun.

Most of our weeds, like much of our vermin, have come to us from beyond the sea. Just how they emigrate in every case will never be known; some came as legitimate freight, but many were "stowaways." Some entered from border lands upon the wings of the wind, on river bosoms, in the stomachs of migrating birds, clinging to hairs of passing animals, and a hundred other ways besides by man himself. Into the New England soil and that south along the Atlantic seaboard the weed seeds first took root. Also the native plants, with a strong weedy nature, developed into pests of the farm and garden. Many of the native weeds are shy and harmless in comparison with the persistent and pugnacious ones that have like vagabonds emigrated to our shores. Why should it be that plants of another country not only find their way here, but after arriving assert themselves with a vigor far surpassing our native herbs? Dr. Gray, in writing upon this point, says, "As the district here in which the weeds of the Old World prevail was naturally forest-clad, there were few of its native herbs which, if they could bear the exposure at all, were capable of competition in the cleared land with emigrants from the Old World." The European weeds had through long ages adapted themselves to the change from forest to cleared land, and were therefore prepared to flourish here in the rich forest soil that was suddenly exposed to the sun and subjected to other new conditions by the felling of the trees. To go back of this we are not sure that the ancestors of some of our European weeds ever came from the forests, but instead were brought into the cleared-up lands from open regions in the early days of agriculture in the Old World. As civilized man moved westward, the weeds followed him, re-enforced by new native ones that soon vied with those of foreign blood. Not satisfied with this, these natives of the interior ran back upon the trail and became new enemies to the older parts of our land. The conditions favorable for the spreading of weeds have increased with the development of our country, until now we are literally overrun. Weeds usually as seeds, go and come in all directions, no less as tramps catching a ride upon each passing freight train than in cherished bouquets gathered between stations and tenderly cared for by transcontinental tourists in parlor cars. "Weeds," Burroughs says, "are great travelers. . . . They are going east and west, north and south, they walk, they fly, they swim. . . . They go under ground and they go above, across lots and by the highway. But like other tramps they find it safest by the highway; in the fields they are intercepted and cut off, but on the public road every boy, every passing herd of sheep or cows, gives them a lift." They love the half-earnest tiller of the soil, and will crowd around his barns and dwelling, and flourish in his garden and fields so long as he favors them with slight attention to his crops.

The fact is patent that weeds are everywhere, and the best means need to be taken to resist their greater prevalence. In this warfare against them there is no weapon equal to a thorough knowledge of the enemy—that is, an understanding of the nature of these pests, their appearance in all stages of growth, methods of propagation, and dissemination of the seeds. This knowledge is much more highly appreciated in Europe than here. In Germany, for example, they have wall maps upon which the leading weeds are represented. Hung as these are upon the school-room walls, a child, simply from daily seeing these life-like colored drawings of the various pests, will learn their appearance and names. Some such method of instruction is needed in this country, by which the children who are soon to be our farmers and gardeners may become familiar with the troublesome weeds even in advance of their advent, that the proper means may be taken at once for meeting and destroying them. Editors of agricultural papers and professors in agricultural colleges yearly receive many letters asking for the simplest kind of information concerning many common weeds, thus showing the general lack of knowledge upon this important subject. To put a map of a dozen of the most destructive weeds upon the walls of every country school-house in the United States is a great undertaking; but if it were done, the next and succeeding generations of farmers would be the better able to carry on the work of extermination. There are a large number of farmers' clubs throughout the country, and a great deal might be done by hanging a weed chart upon the walls of these halls where farmers gather from time to time for mutual improvement and a better understanding of the ways and means of a more profitable agriculture.

Weeds have been neglected in more ways than one, and just so far as they are overlooked and left to themselves the greater will be the curse. As one looks over the premium lists of our thousands of county and State fairs one seldom sees a prize offered for the best collection of weeds. It seems incompatible with our fitness of things to have a good collection of anything that is bad;

and yet the fact remains that there is no class of plants about which an increase of knowledge is more imperative than these same ugly weeds. A few dollars expended in awards by each fair association would bring together lists of plant pests the exhibition of which would not only surprise but greatly instruct those who see them. It is not less important for the farmers of any district to know of the arrival of a new weed than of the advent of a new fruit or grain.

In this connection, and in conclusion, it is a pleasure to announce that space at the World's Columbian Exhibition has already been set aside for a display of the weeds of the whole country, and preparations are now making for a full occupation of the allotment.

KOREAN MOUNTAINS AND MOUNTAINEERS.

By CHARLES W. CAMPBELL.

AS delineated on a Korean map of the country, the White Head Mountain seems to consist of a circle of jagged peaks inclosing a moderate-sized lake. The description of it in Chinese, in the letterpress department of the Atlas, recites that "Peik-tu San, or White Head Mountain, lies seven or eight days' journey to the west of Hoiryeng (a town on the Korean border), in Manchu territory. The mountain is in three tiers, is two hundred *li*, or sixty miles high, and the circuit of its base covers one thousand *li*, or three hundred miles. On the summit there is a lake eight hundred *li*, or two hundred and fifty miles in circumference, whence flow the three rivers Yalu, Sungari, and Tumen." These dimensions are greatly depreciated in Mr. James's description of the mountain in his book, The Long White Mountain. Nevertheless, lakes in mountain-tops seven or eight thousand feet above sea-level are rare enough to tempt the adventurous traveler to try to explore them; and this one on Peik-tu San yields precedence in interest, historically and geographically, to few others in the world. So thought Mr. Charles W. Campbell, of the English consular service in China, when, on the last days of August, 1889, he left Seoul on the tedious journey, by primitive Korean conveyances, of six hundred miles to the mountain. From his account of the journey, and the discussion it called forth in the Royal Geographical Society, are derived the facts given in this article.

The country traversed during the first four days of the journey was typical of the center and south of the Korean Peninsula. "Korea is a land of mountains. Go where you will, a stretch of level road is rare, and a stretch of level plain rarer still. The view from any prominent height is always the same; the eye ranges over an expanse of hill-tops, now running in a succession of long, billowy lines, now broken up like the wavelets in a choppy sea, often green with forest, but just as often bare and forbidding. Clear mountain brooks or shallow streams rushing over beds of gravel are never wanting in the valleys below, where a rude long bridge, or curling smoke, or the presence of cultivation, leads you to observe the brown thatch of some huts clustered under the lee of a hill." On the fifth day Mr. Campbell "branched into untrodden country for the purpose of visiting a remarkable range called the Keum Kang San, or Diamond Mountain, where the most notable collection of Buddhist monasteries in Korea is to be found. There was a considerable change in the configuration of the land as we passed eastward from Keum-Seng. The valleys contracted into narrow, rocky glens, forests of oak, pine, maple, and chestnut clothed the steeper and loftier slopes, and cover sufficiently thick to delight the heart of the sportsman abounded everywhere." A pass too steep for laden animals had to be crossed with the help of bearers. It is known as the Tan-pa Ryeng, and is the western barrier of the Keum Kang region. "The summit is about twenty-eight hundred feet above sea-level. Thence in clear weather a view of the Diamond Mountains was said to be obtainable, and the name *Tan-pa*, which means 'Crop-hair,' was given to the ridge in the early days of Korean Buddhism, to signify that those who reached this point had taken refuge in the cloister, and should sever their connection with the world by parting with their hair.

"From Tan-pa Ryeng, a journey of sixteen miles in a north-easterly direction brought us to Ch'ang-An-Sa, or the Temple of Eternal Rest, a Buddhist monastery at the foot of the Keum Kang San (Diamond Mountains). These mountains are a remarkable section of the main range which practically determines the east coast of Korea. Elsewhere the aspect of the chain is tame enough, but in the north of the Kang-wen province it suddenly starts into a towering mass of irregular, precipitous rocks, whose appearance earned for them many centuries ago their present designation. Viewed from the Eastern Sea, which is not more than thirty miles off as the crow flies, their serrated outline is very striking, and must always make them conspicuous. The district they occupy is a fairly well defined one, some thirty miles long by twenty broad. Few places are more renowned in any country than these mountains are in Korea; in popular estimation they are the *beau-idéal* of scenic loveliness, the perfection of wild beauty in Nature. I found that both Chinese and Japanese spoke and wrote of them, but more because they are a Buddhistic center than for any other reason. At Seoul a visit to Keum Kang San is quite fashionable, and supplies all the material necessary for reputation as a traveler. Buddhism evidently found a home in these secluded mountains soon after its introduction into Korea, which Chinese and native records tell us occurred in the latter half of the fourth century after Christ. A Korean book—the Keum Kang San Record—states that Ch'ang-An-Sa was restored or rebuilt at the beginning of the sixth century, and at the monastery itself tradition dates the oldest relics from the T'ang period (A. D. 618 to 907). At present upward of forty shrines, tended by three or four hundred monks, a few nuns, and a host of lay servitors, are scattered over the east and west slopes of the Diamond Mountains. The great majority of the monks are congregated at the four chief monasteries, and the nuns possess a small sanctuary or two where they find sufficient to do, apart from religious exercises, in weaving cotton and hempen garments and other womanly occupations. The monks, when not in residence at the monasteries, travel all over the country, alms-bowl in hand, chanting the canons of Buddha from door to door, soliciting subscriptions to the building of a new altar or for the repair of an old one, and begging from day to day the food and resting-place which are rarely denied them."

The route followed a rough torrent winding up the west slope to the water-shed—which is 4,200 feet above sea-level, and the highest point reached in the journey across Korea—and descended the eastern flank by a wild mountain-path. "The monastery of Ch'ang-An is superbly situated a little way up the west slope. The lofty hills which wall in the torrent on the north recede for a few hundred yards, and rejoin it again, leaving in the interval a semicircular space of level ground, upon which the temple is built. Nothing could be more effective than the deep-green setting of this half-circlet of hills, rising up like a rampart from the rear of the buildings, and rendered additionally pleasing to the eye by a symmetrical covering of leafy forest and shrub. In front, the water swishes and swirls through rough, tumbled granite blocks, here and there softening into a clear pool, and beyond this again towers a conical buttress of the Keum Kang San, thickly clothed with pines and tangled undergrowth for half its height. The peak possesses the characteristics of the range. Gaping seams and cracks split it vertically from the summit down until vegetation hides the rock, at sufficiently regular intervals to give one the impression of looking at the pipes of an immense organ. The topmost ribs are almost perpendicular, and gleam bare and blue in the evening sun; but lower down the cracks and ledges afford a precarious lodging to a few conifers and stunted oaks." The other mountains along the route occupy equally pretty situations. Soon after crossing the Keum Kang range, Mr. Campbell struck the Japan Sea. A journey of sixty miles along the coast brought him to Wen-san, one of the ports opened to trade by the treaties with foreign powers. Hence he followed the coast-line northward for six days, passing through a number of populous towns, to Puk-ch'eng. Trade, which was not active on the Seoul-Wen-san route, was particularly stirring along the east coast. It is mainly in Manchester cottons. Fairs were common between Wen-san and Puk-ch'eng—as they are in all the populous districts of Korea. "The road was always animated with a concourse of merry, brightly dressed people, wending their way to the market town; women carrying jars and baskets of melons, pears, chillies, etc., on their heads, and babies on their backs; bulls and carts laden with brushwood for fuel; produce of all kinds, including grain and dried fish, borne by ponies and men; sturdy, half-nude coolies, perspiring under lofty, wooden frameworks, to which assortments of earthenware pots and turned wooden dishes are attached; and, more numerous than all, the pleasure-seeker, or *ku-kyeng-kun*, in holiday dress, strutting along in company with a batch of friends, gesticulating, laughing, and cracking jokes productive of the most hilarious mirth. Such throngs greeted the foreigner with amused surprise, sometimes a trifle rudely, but always good-naturedly. The women, in most cases, behaved as properly conducted Korean women ought to do when their faces run the risk of being scanned by a stranger, and turned their backs upon him; yet frequently all scruples vanished before an overpowering curiosity to take in the particulars of so odd a costume, or to discuss the singularity of the equipage. The main street of the town or village is the market-place. It often widens into a sort of place or square, where straw booths are hastily erected for the occasion; but, ordinarily, each man exposes his wares on some boards, or on a cloth spread on the ground in the best spot available. The articles for sale are of the simplest."

From Puk-ch'eng Mr. Campbell took the direct, across-country route through Kap-san, to Peik-tu-san, in preference to the more interesting circuitous route, because of the lateness of the season. Following the Peik-ch'eng River to its source, he then, next day, after leaving the city (September 24th), reached the crest of the range which here fringes the highlands of North Korea. The top of the pass, called Hu-ch'i Ryeng, is 4,300 feet above the sea; thence to the Yalu, at Hyei-san, a distance of a hundred miles, there was a gradual descent, with one remarkable irregularity, to an elevation of 2,800 feet. "The aspect of the country had completely changed. We had left some valleys producing rice and cotton, and had entered a plateau-like region, where these crops were impossible, their places being taken by oats, millet, and hemp. At first our way lay through a forest of spruce, pine, birch, and oak, broken by an occasional marshy glade; to this succeeded an undulating country, which bore traces of being recently cleared. Clearings were made simply by setting fire to the forest—a process which I saw in operation. The population was scanty, but evidently increasing; the houses were log-huts, plastered with clay, roofed with thatch or shingle, and fenced with palisades of stakes six or eight feet high. Game hereabouts was very plentiful. . . . Tigers, leopards, and bears are also said to be easily obtainable. The tiger, indeed, is a fruitful subject of discussion. From Wen-san to Peik-tu San, and thence to Peng-yang, I heard endless stories of the brute's ravages, and more than once I was asked to delay my journey to shoot a 'man-eater.' In the Yalu backwoods I passed through a deserted clearing, where four out of a total of ten inhabitants, had become the prey of a man-eating tiger during the previous winter and spring." Large tracts of cultivated land became common near Kap-san; and the neighborhood is said to contain most of the mineral wealth of Korea; gold, silver, and lead being worked at several places, but with sorry appliances and little skill. There is no doubt that the country is rich in useful and valuable minerals, but it has yet to be ascertained whether they can be worked at a profit.

The first view of the White Head Mountain was obtained from the crest of the ridge overlooking the Yalu, about thirty miles north of Kap-san. "Its renown was at once comprehensible, for, distant as it was, the view was majestic. The white, irregular mass towered, without any marked or prominent peak, head and shoulders over the surrounding hills, though one could see that it was not lofty, as mountains go. . . . Just at the point where this mountain is first visible a small temple has been erected for the purpose of offering sacrifices, which is done by the King of Korea every year on the 4th of the eighth moon (August) to the Peik-tu San deities. At Seoul I was led to believe that the officials deputed to perform this function actually ascended the mountain, but they evidently preferred a compromise, the efficacy of which has apparently never been doubted."

The rest of the journey to the mountain, with only hunters' paths and blazes through the forest, which was made in the first days of October, was beset with difficulties on account of the wintry weather. The last settler's hut was passed, and after that the party had to depend on the hunters' huts, which had been deserted for the winter. When two or three miles from the end of the journey, the best guide who could be depended upon fell in a fit brought on by overexertion. The superstitious Koreans attributed his paroxysms to the malevolent *san sin*, or mountain genii, and spent the night in offering prayers and propitiating sacrifices of rice to the offended deities, while Mr. Campbell doctored the man with Liebig's extract. The man had somewhat recovered from his disability, but in view of the discontent of his party, and the risk of going farther into the wilderness under the circumstances, Mr. Campbell made no further attempt to reach the top of the mountain.

This mountain, the Old White Mountain, as it is called by the Chinese of Manchuria, "is the most remarkable mountain, naturally and historically, in this part of Asia. The perennial whiteness of its crest, now known to be caused by pumice when not by snow, made the peoples that beheld it from the plains of Manchuria give it names whose meanings have survived in the Chinese *Ch'ang-pai Shan*, or Ever-white Mountain. This designation, obviously assigned to the White Mountain alone, has been extended to the whole range without apparent reason, for no other peak of it, so far as is known, can pretend to perennial whiteness, whether of pumice or snow. . . . The great point of interest in the mountain, apart from its whiteness, is the lake—twelve miles in circuit, according to Mr. James and his party, the only Europeans who have seen it—which lies in the broad top of the mountain at a height of 7,500 feet above sea-level, and is supposed to be the source of the three rivers, Yalu, Tumen, and Sungari. The *Tei-Tei-ki* (Great Lake), as the Koreans call it, is the nucleus of a mass of legend and fable. It is a sacred spot, the abode of beings supernatural, and not to be profaned by mortal eye with impunity. Curiously enough, neither Chinese nor Koreans have the faintest notion of the real character of Peik-tu-San. The Chinese say that the lake is an eye of the sea, and the Koreans tell you that the rock of which the mountain is composed 'floats in water,' for lumps of pumice were common on the Yalu at Hyei-san. My crude geological explanations, that this *cho-san* (ancestral mountain) of Korea was a burned-out volcano, whose crater had been filled with water by springs, were listened to with polite wonder and treated with less credulity than they deserved. I pointed to the black dust, to the clinkers, and to the rocks lining the banks of the Yalu for miles, many of which looked as if they had been freshly ejected from some subterranean furnace, but to no purpose. If the occurrences I had spoken of had taken place, they must have been handed down by tradition, and it was useless to cite lapse of time—Koreans are ignorant of geological periods—to people whose history extends as far back as four thousand years ago. According to my observations, most of the forest between Po-ch'm and Peik-tu-San grows on volcanic matter, which was without doubt ejected from Peik-tu-San during successive eruptions. The general inferiority of the timber hereabouts to that of the rest of Korea led me to examine the soil wherever an uprooted tree or a freshly dug deer-pit furnished the opportunity. Beyond a thin coating of leaf-mold on the surface, there was seldom anything else than broken pumice, broken to the size of a very coarse sand. According to the hunters, this was the subsoil everywhere in the forest. . . . Nearing the mountain, we get the clearest evidence of the character and recency, geologically speaking, of the eruptions which spread this vast quantity of volcanic material over such a wide area. Ten miles due south of the White Mountain, the Yalu, now eight or ten yards broad and very shallow, flows between banks like a railway cutting, sheer, clean, and absolutely devoid of vegetation, for denudation was too rapid to permit the slightest growth. The sections thus exposed were often over a hundred feet in depth, and at one of the deepest portions I counted thirteen layers of black volcanic dust, all varying in thickness, and each separated from the layer above by a thin stratum of volcanic mold. So fine was this dust that the least breath of wind caught it and scattered it freely over the adjoining snow, to which it gave a grimy, sooty appearance. The forests of South Manchuria, though uninhabited now, were, we learn from Chinese records, the home of many races in ages past. The comparatively recent kingdom of Ko-ku-rye, which arose in the first century B. C., is said to have occupied the Ch'ang-pai Shan and the head-waters of the Yalu River." Very few, if any, traces of these ancient peoples are found now; but this is hardly to be wondered at, considering their low civilization and the temporary character of their dwellings.

Captain Younghusband, speaking to Mr. Campbell's paper, described the trip which he, Mr. James, and Mr. Fulford made to the mountain from the northern or Manchurian side in the summer of 1886. At the foot of the mountain they found some most lovely meadows covered with iris, lilies, and columbine, surpassing even those of Kashmir. "Passing on up through the forest, we came to the summit of the Ch'ang-pai Shan. Before us were two prominent peaks seen from the north side—there are really five all round—and between these the saddle. Arriving there, we expected to see a view on the other side toward Korea; instead of that, however, we saw, straight under our feet, this wonderful lake situated right at the top of the mountain. It was of the most clear deep blue, and surrounded by a magnificent circle of jagged peaks, ascending one of which I got a clear view of all this country, over which Mr. Campbell traveled later on. We saw through the forest the course of this Yalu River and the Tumen River, which both rise on the spurs of this mountain, and out of this lake flowed a small stream which eventually runs into the Sungari, perhaps the most important tributary of the great Amur River, which flows along the southern edge of Siberia. . . . The whole of this country shows signs of a volcanic origin. There is no doubt that this mountain Peik-tu San was formerly a volcano, and that this lake is the crater of the volcano."

Mr. Campbell's narrative and the discussion furnished some pleasing pictures of Korean life and character. It is a curious fact and suggestive that the most conspicuous and seemingly the most lasting traces left of ancient Korean settlements are the strawberries. The beauty of the situations of the Buddhist monasteries was remarked upon. For centuries Buddhism has been under a ban in the country, and its followers, driven from the settled country to the mountains, have established their monasteries there, out of the way. In selecting the most beautiful retreats for the study of their religion, they have followed, said one of the speakers, the bent of Korean character. "These monasteries form hotels for those travelers in the country who take their delight in leaving town life, taking simple food, and traveling day after day, piping their way on the roads, rejoicing in the beauty of the country. I should think in hardly any country in the world the ordinary rustic takes so much delight in Nature as in Korea; when he goes with you up the mountains, and, on arriving at the top, you expect him to sigh as if nearly dead, he will expatiate on the beauty of the scene before him. In this love of scenery, as in many other points, the Korean differs greatly from his neighbors the Chinese."

The Korean hamlets are of two kinds, "the purely agricultural, and those which depend as much on the entertainment of travelers as on farming. The site of the agricultural village is a hill-slope facing the south. Over this, low, mud-walled, straw-thatched hovels, each standing in its own piece of garden, which is protected by a neat fence of interlaced stems, are scattered at random, and there is not much of an attempt at a street anywhere. Every house has its thrashing-floor of beaten clay, the workshop of the family. The stream which runs past the foot of the hill, or courses down a gully in its side, is lined with women and girls washing clothes with sticks instead of soap, preparing cabbages for pickle, or steeping hemp. Seen from a distance, these places are quite picturesque. The uneven terraces of thatch are brightened by the foliage and flowers of gourds and melons which climb all over the huts. In the gardens surrounding each house are plots of red chilli, rows of castor-oil plants, and fruit trees such as peach, apricot, pear, and persimmon. The roadside village, on the other hand, is generally a most unlovely spot. The only street is the main highway, which is lined on both sides by a straggling collection of the huts I have mentioned. Heaps of refuse, open drains, malodorous pools, stacks of brushwood for fuel, nude, sun-tanned children disporting themselves, men and women thrashing grain, and occasionally a crowd of disputants—all combine to make it a very indifferent thoroughfare. Most of the houses are inns or eating-shops. The main gate of the inn leads directly from the street into a quadrangle bounded on two sides by open sheds, which are provided with troughs for the feeding of pack-animals, and on the other two sides by the guest-rooms and kitchen. The court-yard is often dominated by a powerful pig-stye, and littered with fodder or earthenware pitchers and vats." General agriculture is, however, not so elaborate and fruitful as in Japan and southern China. "The principal farm animal is the ox; in mid-Korea he is a splendid beast—hardy, tractable, and bearing a strong resemblance in build to our short-horned stock. A cane or iron ring, for which his nostrils are pierced when young, suffices to control him, and he is early accustomed to his constant work of load-carrying. Plowing is done with the ox; rarely or never with the pony. Dairy produce is unknown, or nearly so. Draught cattle and ponies are fed on coarse fodder and a boiled slush of beans, chopped straw, and rice-husks. The remaining domestic animals are black, hairy pigs, wily gaunt creatures, and horribly loathsome; wolfish dogs, possessing a surprising nose for foreigners; and fowls that almost equal their wild congeners, the pheasants, in powers of flight and wariness."

An incident which happened to Mr. Campbell during his journey—in which a woman by bullying and coaxing forced a party of unwilling bearers into his service—gave a fresh blow in his mind to the theory of the subjection of women in the East, and strengthened his opinion that "women in these parts of the world, if the truth were known, fill a higher place and wield a far greater influence than they are usually credited with."

In a paper read before the French Association for the Advancement of Science, on the Succession of Media inhabited by the Ancestral Series of Man, M. Fauvelle presented a genealogical table of beings in which, waiving the question of plants, he showed forth the successive development of animals, beginning in sea-water, continuing afterward in fresh water, then in moist and marshy soil, to reach a higher stage on dry lands. The beginning was the cell, which originated in sea-water, an aquatic medium; the climax was man, a product eminently aërian. M. G. de Mortillet, while he recognized the ingenuity and attractiveness of M. Fauvelle's system, suggested that, to put it on a solid base, it would be necessary to prove that sea salt existed at the time of the origin of life.

In a paper at the British Association on the worship of meteorites, Prof. H. A. Newton gave accounts of divine honors having been paid to meteoric stones in early times, and of myths and traditions pointing to such worship. Particular attention was directed to the indications of this cult that are found in Grecian and Roman history and literature.

DUST AND FRESH AIR.

BY T. PRIDGIN TEALE, F.R.S.

EXCEPT in the case of museums, few serious attempts have been made to exclude dust from rooms, closets, cupboards, and drawers, to the contents of which, not infrequently, dust is simply ruinous. We allow dust to run riot among our things of value, and then go to considerable expense to render them clean again, only to start them on a fresh career of defilement.

Looked at in the abstract, is not our passive capitulation to dust incomprehensible? When I enter an office in a town and see the window-sills and papers dotted with soot, or go into a bedroom and see the toilet-table defaced with blacks, and know that the soot and the blacks need not be there, I can not refrain from asking how comes it to pass that we so patiently submit to such perpetual discomforts. You will doubtless reply, We agree with you as to the existence of the evil, but how is it to be remedied? My object is to offer some practical suggestions whereby you may so far mitigate and reduce the evils of soot and dust as to make them tolerable, perhaps even to lay down principles by which the evils can be annihilated in those instances in which the result to be obtained is worth the cost of achievement. For the practical purposes of every-day life it may turn out that we had better be content with approximate perfection, a condition of existence which compels us to be content with approximately pure water from a filter, and approximately pure air in our living-rooms.

If dust is to be kept out of any cavity, we must first find out why the dust gets in, in spite of good workmanship and accurate fitting. The reason is simple, ridiculously simple when stated, but, curiously, it has been little, if at all, thought of, and certainly hardly ever acted upon in practice. And the reason is this: Closets, cupboards, drawers, and boxes contain air; if the air were inelastic and never altered in volume, there would practically be no entrance of dust into these closed cavities. Unfortunately for our cleanliness, air is changing in volume incessantly. We are all familiar with the barometer, and most of us no doubt understand why the quicksilver rises and falls in the glass tube, or why, in the aneroid barometer, the index moves to right or left. Let us consider what these changes mean, and what they record.

When the air around us becomes condensed—shrinks into a smaller volume—it becomes heavier, puts greater pressure on the surface of the mercury, and makes it ascend in the tube; then the mercury is said to rise. When the air expands—swells into a larger volume—it becomes lighter, the pressure on the mercury is less, the mercury sinks in the tube, and the barometer is said to fall. Therefore, every change of height of the quicksilver which we observe is a sign and measure of a change in the volume of air around us. Further, this change in volume tells no less upon the air inside our cases and cupboards. When the barometer falls, the air around expands into a larger volume, and the air inside the cupboard also expands and forces itself out at every minute crevice. When the barometer rises again, the air inside the cupboard, as well as outside, condenses and shrinks, and air is forced back into the cupboard to equalize the pressure; and, along with the air, in goes the dust. The smaller the crevice, the stronger the jet of air, the farther goes the dirt. Witness the dirt-tracks so often seen in imperfectly framed engravings or photographs. Remember, ladies and gentlemen, whenever you see the barometer rising, that an additional charge of dust is entering your cupboards and drawers. So much for the barometer, which is a very restless creature, rarely stationary for many hours together. But this is not all. We also have the thermometer. The temperature of our rooms varies daily—often considerably—between midday and midnight, and greatly between summer and winter. What does the thermometer tell us? Not less than the barometer does it tell of change of volume of the air, though it is probably not so rapid in its effect upon the air in inclosed spaces as is the change of volume indicated by the barometer. Many of you have seen a fire-balloon. The heated air, filling the balloon, expands, and becomes lighter than the surrounding air, and up goes the balloon, until, the source of heat having become exhausted, the contained air cools, contracts, becomes as heavy as the surrounding air, and down comes the balloon again. So, also, as temperature rises outside our cases, the increased warmth is slowly conducted to the air inside the case, which expands and escapes through the crevices. Then, when the time for cooling comes, the air inside slowly contracts, and back rushes the air through the crevices, and again in goes the dust. Thus, we see we have two factors constantly acting, one or other tending to produce daily, nay, hourly, changes in volume of our dirt-carrying air.

In order to inform myself of the amount of change of volume that could, under extreme conditions, possibly take place, I asked Prof. Rücker to kindly calculate for me the change of volume that would take place in one hundred cubic feet of air, between a temperature of 30°, i. e., just above freezing-point, in combination with the barometer standing at thirty inches, or about "fair," and a temperature of 60°, combined with the barometer standing at twenty-nine inches, or "stormy." He told me that the difference would be about ten cubic feet, or one tenth; in other words, that a closed case of one hundred cubic feet, if hermetically sealed at a temperature of 30°, with the barometer standing at thirty inches, would have to resist the pressure equivalent to the addition of ten cubic feet, when the temperature rose to 60°, and the barometer fell to twenty-nine inches. Have we not now discovered the reason why dirt enters closed spaces? What shall be the remedy?

Seeing, then, that air will find an entrance, and in the nature of things must get in—well, we must let it in, not at innumerable uncovenanted small crevices, but at our own selected opening, specially provided. Then we are in a position to strain off the dust by providing the selected opening with a screen, which acts as a filter. These, then, are the general principles on which we must act. The rest is a question of detail. The details range themselves under three heads: 1. What is the most effective, or the most generally applicable filtering material? 2. Given the filtering material, what ought to be the proportion between the area of the screened opening and the cubic contents of the case to which it has to be fitted? 3. What, in any particular instance, is the best situation for the filter?

What is needed in our filtering material is that it shall readily allow air to pass through, and shall also possess the quality of arresting in its meshes fine particles of dust. For some purposes it may suffice to use a coarse canvas, the threads of which are not too closely twisted and have an abundance of fine fibers projecting from them, thereby reducing the small squares of the woven texture to a still finer mesh. The material I have used most frequently is "bunting," but it has disappointed me. When examined by the microscope many of the small squares of mesh are seen to be deficient in delicate fibers standing out from the threads, which would enhance the filtering power of the texture. Lately I have tried other materials, domette, flannel, and cotton-wool between layers of muslin, such as is used for dressing wounds under the name of Gamgee tissue. Cotton-wool is probably the most perfect filter. Indeed, so perfect is it that in the new science of bacteriology it is used as an effective means of excluding dust and germs from flasks in which experiments are to be carried on. In order to put various textures to an exact comparative test, an experiment was tried. Having selected six quart bottles with wide mouths, I tied over the mouth of each a piece of the filtering tissue which I wished to test. The bottles are not liable to crack, as wooden boxes are; the only access for the interchange of air in the interior was through the filtering texture. I thus had a means of testing the comparative value as strainers of the various materials. Within the bottles were placed glass slides on which any dust that was carried in might settle. The experiments were begun on May 5, 1891, and the slides were taken out on January 6, 1892, and most carefully photographed by Mr. Lafayette, and made into lantern slides.

The bottles were placed near a window in a room in the building of the Leeds Philosophical Society, i. e., quite in the center of Leeds. The materials tested were: canvas; bunting; ordinary flannel; domette flannel, rough side in; domette flannel, rough side out; cotton-wool, one inch thick.

The results of the experiments show that as a consequence of eight months' exposure, including a week of the worst fog I ever knew in Leeds, three of the filtering tissues admitted a very appreciable amount of dust, viz., coarse canvas the most, bunting coming second, ordinary flannel admitting less than either. The other three bottles were screened, one with thick domette rough side in, one with domette rough side out, and one with cotton-wool about an inch in thickness. The last three show hardly a trace of dust. Curiously, the cotton-wool shows a trace more than the domette flannel. The explanation of this I suspect to be that the cotton-wool was not tied firmly enough round the neck of the bottle, which had no rim, and that some air passed between the bottle and the wool, instead of through the wool.

Another experiment which I tried was to fit up a cupboard with panels of double domette flannel. After the fog, to my surprise, the inner screen had become more or less black, showing that black particles had passed into the cupboard, but with this remarkable difference: whereas the outer flannel was almost uniformly black from top to bottom, the inner flannel was divided into four squares of different shades of blackness, corresponding to four spaces between shelves. Of these four, the lowermost was almost as black as the outside, and the uppermost was almost clean. I just mention this as a fact which needs an explanation, but without suggesting one.

There is one error which I think has been committed in the screens made for me, and it was pointed out by my friend Mr. White, the architect, of Wimpole Street. The filtering material is likely to act more effectively if left loose and not stretched tight, as when tense the interstices are stretched and made larger, and when out of sight it might be very loose, almost baggy, with advantage.

Hoping to get some hints as to the comparative value of the various textures under trial, I placed specimens of each under the microscope. It is obvious that both canvas and bunting are of too open a texture, having numerous small holes unguarded by delicate fibers. Judging by the microscope, one would conclude that of woven textures, probably flannel, and still more, domette flannel, are the best, and this judgment seems to be borne out by the experiments with the bottles.

This is a question which experience alone can decide. Doubtless the larger the area of screened opening, the more effective the filtration. For a book-case with glazed front, probably the whole of the back might be made of flannel loosely fixed over the necessary skeleton framework. For a cupboard or closet, every panel should be replaced by a screen. If the closet have a window, all crevices and joints in the window should be pasted up to exclude the soot, otherwise the wind from the outside, or the fires of the house from the inside, will force the air soot through. On the other hand, it is probably true that, given very perfect fitting and workmanship, aided by the interposition of velvet, as hereafter described, where the edges of the doors come in contact with their frame, a much smaller area of filter, perhaps even a simple tube, filled with cotton-wool, may prove to be efficient. These, however, are points on which further experience is needed, and which may, ere long, be settled by experiment.

Where shall we place our screen? This is a question which admits of a variety of answers, and gives scope for endless ingenuity. In anything which is being newly made, such as the cupboards and closets of a new house, or in new furniture, we are masters of the situation. In many of them we may substitute at the back our filtering texture for wooden boards, and perhaps even save expense thereby. In closets we may replace the panels of the door by filtering texture, guarding the closets, if necessary, against thieves by wire netting or iron bars fixed on the inner side. As a rule, chests of drawers may have the filter over the whole surface at the back, care being taken that the back of each drawer falls half an inch short of the top of the drawer, to allow free entrance of air from the screen. In one set of drawers, so placed that I could not get at the back, the difficulty was got over in this way: In the front of each drawer a series of twenty holes, of an inch diameter, was made for admission of air. The filter, on a frame, was fixed on the inner surface of the front of the drawer, so that the material should stand half an inch away from the holes. A somewhat similar plan was adopted in a bureau. About twenty large holes, two inches in diameter, were cut in the wood-work at the back, some of the holes being opposite pigeon-holes. Then the whole was covered with bunting, on a frame so arranged that the bunting was fully half or two thirds of an inch away from the wood. Another method has been adopted at the Yorkshire College for some of the cases. The filter was applied at the roof, somewhat after the fashion of a weaving-shed roof, the vertical face being filled in by the screen. Again, Mr. Branson has provided a roof filter for a case of scientific instruments, by placing the screen in the roof of the case, and protecting it by a false roof two inches above it, to prevent its being choked by falling dust.

What shall we do with crevices and cracks? At first, I hoped that narrow chinks might be ignored, on the principle that easy passages of air through an ample screen would virtually stop off currents through narrow spaces. In this I have been disappointed, as, in some cases, a chink, though apparently narrow, has proved too accommodating to the passage of air, and a more ready channel than the interstices of flannel. My rule now would be to close or guard with filtering material every place where the door comes into contact with its frame.

The plan I have adopted with the doors of several cupboards and closets is this—to put strips of cotton velvet wherever the door comes into contact with its framework. On the side where the hinges are, the velvet is glued and sprigged to the edge of the door; on the other side and the top the velvet is fixed to the rebate against which the door presses. If the door belong to a closet, and the bottom is not in close contact with the floor, a small piece of flannel or cloth may be fixed along the inner side of the bottom of the door, so as to form a curtain which closes the gap, and filters any air that passes through.

Such, then, are the principles which may guide us to a victory over dust, and such are some of the details whereby we may work out a method by which the victory is to be won. Do not suppose that I claim to have completely conquered the enemy; but a beginning has been made, a beginning definite enough and assured enough to encourage others, and especially architects, to study the question and to make trials. If they will but work with determination to conquer, they may confer upon the community a most welcome amelioration of some of the smaller miseries we have to submit to.

And now let me venture to tell you what I should do were I to construct an office in the center of a town. I should begin with the fireplace. Let it be constructed on the principles I have been teaching for the last ten years, and which were brought to a focus in my lecture at the Royal Institution in 1866—principles which are at last influencing the construction of fire-grates throughout the kingdom. Shortly stated, they are:

1. The back and sides of the fireplace to be fire-brick, built solid.

2. The depth of grate from front to back never to be less than nine inches.

3. The back to lean over the fire, not to lean away from it.

4. The front bars to be vertical and thin, not horizontal and thick.

5. The ash-place under the grid to be made into a closed hot chamber by a movable shield, named an "economizer."

The effects of this construction are:

(*a*) Great diminution of dust, since the ashes fall into a closed ash-chamber.

(*b*) Better warming of the room, with a diminution of about one fourth in the quantity of coal used.

(*c*) Diminished draft across the floor, from diminished roar up the chimney when the fire is burning briskly.

(*d*) Diminished production of soot.

These are the principles which I have urged, and they are open to every one to adopt. I do not speak of a further improvement, as it is the subject of a patent, and is not open to every one to copy.

Having made sure of my fire, the next step would be to secure admission of air to supply the fire, without making a draft or introducing dirt. As far as I know this is best done by the "Harding diffuser," which admits air directly from the outside and delivers it through a series of small jets near the ceiling. To shut out the smuts the air passes through a canvas screen placed diagonally in a flat tube, which leads up to the "diffuser" and gives a filtering area about six times the sectional area of the tube. This air is admitted into the room by a legitimate channel, and is filtered. The "Harding diffuser" was once patented, but the patent has lapsed.

Having thus secured a supply of air for the chimney, we can afford to deal with the windows, and make them air-tight, without fear of the chimney smoking. Now I should like to see a revolution in windows, at any rate, wherever we can be content with panes of moderate size, and can have the heart to surrender plate glass.

Three things are required of a good window:

1. That the outside of the window may be cleaned by a servant standing inside the room, whereby the risk and expense of cleaning from without are avoided.

2. That it shall exclude wind and dirt, even under the stress of a gale.

3. That the air of the room, especially in frosty weather, shall not be itself so chilled by contact with the large surface of glass as to cause induced cold currents, which have not even the merit of being air freshly introduced.

To attain these points, the sash window must be abandoned. The window must be so divided that one half vertically, or in a large window one third, may open inward on hinges, the other half or two thirds being fixed, and therefore wind-tight; the breadth of each division to be such that a servant's arm can reach out and clean the outer side of the fixed window as she stands inside the room. In the case of three divisions the fixed windows would be to the right and left of the hinged window. The hinged window should be in two or three divisions, according to the height, not in one large casement from top to bottom. Thus have we provided for my first requirement, the cleaning of the window. The hinged window must be so constructed that when closed the framework of the window locks into a double rebated fast frame, after the manner of a jeweler's show-case. Then, if well made, it would fit tight and keep out wind and dust. This provides for my second requirement.

Lastly, the panes should be doubled—that is, a second pane must be placed inside the ordinary pane at a distance of about five eighths of an inch. The outer pane is fixed by putty in the usual way. The fixing of the inner pane is peculiar and all-important. The inside of the frame is cut to receive the glass exactly in the same manner as the outer side for the outer pane, but the inside pane must not be fixed by putty, but is held in place, "sprigged" firmly against its rim, "the rebate," by small nails, two in each side, very carefully put in. Why do I insist upon this mode of fixing the inner pane? For two reasons: one, to make it easy to remove the inner pane if ever it should be necessary to clean the inside of the two panes; the other reason is, to enable me to render cleaning of the inside unnecessary. How is this achieved? By facing the flange, against which the pane is pressed, with cotton velvet. The air that must perforce pass in and out of the space between the panes must pass the velvet, and be filtered. Two windows of my bedroom thus treated five years ago have never needed to be cleaned; and a pane, which was removed at the end of four years for inspection, was absolutely clean. Another advantage of the double panes is this: When my other windows with single panes are steamed all over, and even glazed by the frost, the outer panes of the double window show hardly a trace of unfrozen steam; the inner panes are never steamed. Again, a thermometer placed between the panes has never been below 30° all this severe weather, even though a thermometer outside the window has been several times below 20°.

Lastly, I would treat the cupboards and drawers after the manner already described. The result would be, not absolute freedom from dirt, nor absolute protection from London fog, but such a departure from what is commonly experienced as to make the experiment well worth all the trouble it costs.—*Journal of the Society of Arts.*

Of the three hundred and twenty-three asteroids known on February 1st, seventy were discovered by American astronomers—forty-eight by Peters and twenty-two by Watson. Peters stands second on the list of successful discoverers. Palissa, who is first on the list, is credited with the discovery of eighty asteroids.

THE COLORS OF WATER.

By CARL VOGT.

"GRANDPA," asked my two grandchildren, as if with one voice, "shall we pass over the blue lake when we go to Geneva?"

Our residence at Salvan, a charming village of the canton Wallis, about a thousand metres above the level of the sea, was nearing its end. The return journey was the subject of lively conversation, and we were almost entirely occupied with the fancies of the children, who asked no end of questions. "We shall go across the blue lake," I said. "First we shall go down to the station. Grandma and I will go in carriages, you others will walk. Then we shall take the railway train and go down to the lake. The steamboat will be there, and as soon as we are aboard—"

"Grandpa," interposed the others, "why is the lake so blue?"

I was somewhat confused by these questions. If a fool can ask more questions than ten men can answer, a child can perplex more than a hundred grandpas. An evasive reply, like "It is blue because it is not yellow like the Oder at home," was not available with my children. It is an old observation that the simpler a phenomenon of Nature appears at first sight, the more complicated it is in fact; but it is always well to recollect that there is no simple phenomenon in Nature, that all that ever happens or is perceived by our senses is only a result of very different or even opposing forces and causes, which we must not only learn by observation, but must also separate from one another by experiment, if we would come to a conclusion that has hands and feet. Every one can see that the Lake of Geneva is blue, and most persons regard the subject as quite simple and clear, without probing further into the causes of the blue color. But if a child in his *naïve* candor asks for the reason of this color which has struck him because the waters of his home are not like it, there floats before the mind of the expert an unanticipated multitude of problems in optics involving the most difficult laws and broad knowledge, and over which mathematicians and physicists and students of every kind, artists and poets, have racked their brains, without having ever reached a definite solution. How, then, shall he convey ideas to a child which shall give an answer to the question adapted to his powers of comprehension?

I was thinking of preparing a small water-color drawing, when the children asked their eager question. Why should I not invoke the Muse to the help of art? A large cylindrical glass, holding a litre, stood on the table, filled with the superb water that gushes out of the slates fresh and cool, crystal clear, and chemically pure.

"Look at the water in the glass," said I; "of what color is it?"

"I don't see that it is of any color," said one. "It is red," said the other.

"But that comes from the flowers that are behind it," replied Annie. "Come round to where I am; it doesn't look red from here."

Lili ran round the table, and confessed, a little vexed, that the water was not red. She had a disposition, perhaps, like Lessing's, who was dissatisfied because the spring was always green, and not, by way of change, sometimes red.

"Is it not true, grandpa, that water has no color?"

"Yes, dear child, it is blue, but so little so that you can not see it."

"Can you see that it is blue?"

"No; but still it is blue. Look at this."

I took a little ultramarine on the end of the brush and mixed it with the water. "Does it look blue now?"

"No; I see nothing."

"Nor I. But you saw how I put a little blue color in it with the brush."

"Yes, but there was not enough of it. Put more in."

I silently took the glass and set it on a piece of white paper in the bright sunshine. "Now look from above down into it."

"It is blue!" said the little one, clapping her hands, "but only a very little."

"Look at it from the other side, where the sun is shining into it. Is it not a little bit red, like the bell-flowers which you picked yesterday?"

"That is wonderful," said the little one. "It is blue from above, a little bit red in the sun, and when we look at it from this side of the room we see nothing!"

"Think about it a little. The glass is as broad as my finger is long. But it is at least three times as high as my finger. When you look at it from the side, you see only a finger's length of water; but when you look down into it, you see through three fingers' length of water—three times as much. You see it blue from the side, and three times as blue from above, don't you?"

"Is that really true?" said the little one, as she measured with her finger. She nodded that she was satisfied.

"Now imagine that the water is as deep as the height of the church-steeple, and deeper—that it reaches from here up into Salvan and down to Vernayaz. Then you would see the water from above it all blue."

"Is the lake, then, really so deep?"

"Yes, and deeper."

I will not continue the conversation any longer. It went on with various simple experiments, beginning with differently colored stones, which I let drop into the water, and then placed on the white, then with setting the glass with its weakly bluish contents on differently colored papers, and ended with my trying to make the children perceive how the colors changed when they were seen through the whole depth of the glass. I will not say that the little ones were brought to a full comprehension of the matter; but they stuck fast to the assertion that water is blue, of an infinitely weak blue, and that the blue color can not be seen till one looks into a certain depth of it.

Physicists first acquired this knowledge by means of an experiment of Bunsen's, who let a piece of white porcelain fall into a tube filled with distilled water, and satisfied himself that the descending piece looked bluer as it sank deeper. Bunsen had, of course, provided that only white light reflected from the ceiling of his room should fall into the tube, and not the blue light of the sky. The experiment has been modified in various ways, and made more convenient, but has always given the same result; and it is now established as a scientific truth that chemically pure water, free from all other constituents, either dissolved or floating, has a bright, clear, blue color.

But there is no such water in Nature, for rain-water, even distilled—water evaporated out of the sea and everywhere, and carried on in the form of clouds, and falling in drops—even that rain-water contains some dissolved substances, and still more of little microscopic bodies that are floating in the air which the drop carries with it in its fall.

Yet we can assure ourselves at least as to the dissolved salts, in which sea-water, for example, is rich, that they are all, particularly common salt, colorless in the crystalline condition, and therefore have not the least influence on the color of sea-water. Seamen and sailors, although uninstructed in this matter, and without knowledge, know very well that they, going away from the coast, in a short time reach the clear, the "blue water," and then sail over deeps till they can not reach the bottom with their anchors.

I have already said that every phenomenon in Nature is a complex affair, and depends on many causes and conditions. This is true of the coloring of large masses of water, as of lakes and seas, which are indeed, as is known, of very different shades. It may be permitted to consider here a few of the conditions that have an influence on the general effect.

A still-water surface forms a mirror which reflects those colors of the horizon that fall upon it at the same angle as that under which the eye stands to it. When I am at the shore of a quiet sea, or of a still lake, the water beams with the colors of the horizon. In a bay surrounded by woods, I see a deep gray; on the broad surface at sunset, the liveliest yellows and reds; looking straight down from my boat, the blue of the sky over my head.

These reflected colors concern the physicist the least, for he knows that every reflecting surface returns them; but they interest the painter almost exclusively. They constitute the tone of his landscape; they enliven the otherwise monotonous, dead surface, and he as well as the looker at his picture receives chiefly the impression of them. They are for the most part the colors of the lower horizon, for the point of view of the spectator is usually only a few metres above the level of the water.

Thus with the smooth mirror. But the scene changes immediately upon the slightest agitation. It is very seldom that the sea is quite still. The waves form hills and valleys, their surfaces are more or less inclined, and they reflect not the horizon with its down-toned colors, but the more saturated tints of the zenith. Whoever has seen the Mediterranean Sea or the Lake of Geneva under a cloudless sunset, and a slight rippling of the waves, will recollect that the surfaces glowing with burning yellows and reds, are broken up by sharp, deep-blue lines; they are the wave-valleys, which, by reason of their oblique inclination, turn the blue colors of the zenith into the eye. But this is not all. With the smooth mirror surface, and lower point of view, the eye not only receives the rays reflected from the surface, but it pierces through the inclined parts of the wave-valleys into the mass of the water, and thus perceives the proper color of the water, more intensely as the small surface of the wave-valley stands more perpendicularly to the eye. If the waves are very short, and follow one another rapidly, this impression of the color of the water will overcome that of the reflection. I can satisfy myself of this fact at any time.

The windows on the western front of my house look toward the Arve, which is here crossed by a dam that causes a fall of about a metre. Above the dam, the glacier-stream, colored a grayish yellow in summer and green in winter, is perfectly smooth; and from my windows, which are situated about six metres above the river, I can see hardly any but the mirror colors, yet a little mingled with the proper color of water, which appears considerably stronger when the sky is covered and its glaring light does not—as the painters are accustomed to say—"eat up" the softer tones. But below the dam the water is in lively motion with endless little racing wavelets, and here the green color comes out so vividly that the reflection almost wholly vanishes. Yet another fact is revealed by the movement. Only with a perfectly smooth mirror surface are the outlines of the reflected objects fully clear and sharp. The reflection is then so perfect that one often hardly knows whether he sees the objects themselves or only their mirrored images on the water; and the lines between water and shore are quite effaced. The slightest movement causes the outline of the mirror picture to appear notched; clearer lines from the horizon creep into the darker colors of the picture, but notches from these, too, spring out over the lines which the outline should have. This phenomenon is so common that we notch the borders of water reflections in colored pictures, as well as in those drawn only in black. I have no doubt that a relationship lies at the bottom of this phenomenon like the fact observed by Colladon, and now often remarked, that water in motion carries the light along with it. A stream of water, flowing through a dark tube out of an illuminated receiver, carries the light along, whether it be white or colored, and shines; why should not moving waves exhibit the same effect?

But enough of these painters' impressions, which, as we have said, are neglected by the physicist, but are still of the highest significance for the beholder as well as for the artist, and, as may result from our representation, are dependent on various factors, among which, besides mirroring, the real color of the water is to be considered.

Let us go a little closer into this matter.

Pure or colorless water containing salts in solution is beautifully blue and perfectly transparent, at least to a certain depth. It is, hence, clear that with the color of all objects visible at this depth, and constantly reflecting the rays of light, is associated under the water a blue tone, more intensive as the depth at which the object lies is greater. The gravels on the shore of a lake or the sea become, when seen through the blue water, as if they were observed through a pane of blue glass; and since all shore figures, with trifling exceptions, are of a yellowish color, they will shine of a more or less green color, and the water on the shore will likewise appear green.

I here lay aside all physical deductions concerning the nature of color. We know that it is not, as was once thought, a property of bodies, but that a transparent body like water, for example, shows a distinct color, because it lets certain colored rays through, but not others, and that a solid body reflects the rays which we perceive, but to a certain extent absorbs the others. The discussion of the nature of color is not of very great importance for our essay.

Blue water also takes on another tint when objects lying on the ground are seen through it, and this mixed color tone depends on the color of the ground. We can easily verify this by the simple experiments described above with blue colored water in a cylinder glass. White bodies, pieces of porcelain for instance, appear light-blue, yellow-green, red-violet, and, the deeper they sink, the more is this shading from blue washed out, till it is destroyed. The red shades vanish first of all.

The depth to which no trace of bottom-colors reaches us is certainly not little, and may, under favorable conditions, be estimated at several hundred metres. But the question is a large one, and we will consider a little more carefully to what extent the more or less favorable conditions I have mentioned have been determined.

I have already said that pure water does not exist in Nature. It always must contain dissolved or floating substances which will change its colors. Peat waters contain brown and blackish organic matters in solution. They may be perfectly clear and transparent, but the colors which the humus acids and similar substances lend them will always produce a certain effect upon them, which will be re-enforced by the dark-brown or black colors of the bottom of the peat lakes. It has also been observed that filtered water from a blue lake on evaporation leaves a white or light gray, and that from green lakes a yellow sediment; and that thus blue lakes contain white matters and green lakes yellow ones in solution, whose colors produce with those of the water mixed tints. The difference in the colors of the Lake of Geneva and of the Bodensee is explained on this principle, but the results of the experiments on which the conclusion rests have been disputed, and there is much room for doubt on the subject. Whatever may be thought of this, it is certain that no water in Nature is perfectly clear and transparent, but is more or less turbid by the presence of other substances floating in it. That this turbidity is of greater or less importance, that we can distinguish at greater or less depths objects swimming in the water, like fishes, or lying on the bottom, are taught by daily experience as well as by experiments which have been made by sinking solid bodies in sunlight and on cloudy days and at different seasons, or by letting down sources of light, such as burning lamps and incandescent electric lights, and ascertaining the depth at which a perceptible glimpse of them can be obtained. It is to be regretted that these as well as other experiments upon the penetrating power of light have been made only in waters not quite clear, as in a few Swiss lakes and the Mediterranean Sea. Whoever has traveled on the coasts of Norway must have been astonished at the transparency of the water in many of the fiords; it is also affirmed that in some of the North American lakes the eye can perceive objects on the bottom at the depth of several hundred metres. Visibility extends to no such depths in either the Lake of Geneva or the Mediterranean Sea. The watér of the Lake of Geneva is more transparent in winter than in summer, but in this lake, as well as in the sea-waters that have been thus far examined, the extreme limits of visibility are at forty-five, and at most fifty metres' depth. Observations in diving apparatus have shown that one is there as in a blue cloud, and can only see some seven or eight metres in a horizontal direction, in exceptional cases twenty metres, and at most twenty-five metres. But the seeing man can dive with the apparatus only to a depth of thirty metres, and, although he can not see clearly, he is surrounded by diffuse light.

The light from above must therefore penetrate more deeply. A more closely approximate measurement has been made by such means as sinking sensitized photographic plates into the water, and exposing them to the light at fixed depths, or by sinking substances which are chemically acted upon, changed, or destroyed by light, so that the measure of the alteration may at the same time furnish the measure of the strength of the acting light. Photographic experiments have shown that a depth of four hundred metres in the Mediterranean Sea is the average limit to which a blackening of the plate can be verified.

Thus light penetrates to ten times as great a depth as our eye, and this is an important point—a whole zone, three hundred metres in thickness, receives light and thus also sends up rays which our eyes can not immediately distinguish, but in all probability perceives through the mixture of the color tones which they produce. It is known that there are other differences than those of blindness to certain colors in the eyes of men, and that our organs may be trained to an extraordinary degree of delicacy in the observation of the finer tints. I once visited the Gobelins tapestry factory in Paris in company with some painters; the workmen could distinguish with ease and indubitably tints which looked identical to our unskilled eyes. There must, to return to our subject, radiate up from that depth to the surface, light, of a bluish color, which makes far less impression on our eyes than the colors called warm, yellow and red, which—especially the latter—are absorbed by the water.

It was formerly believed that total darkness reigned in the greater depths of a thousand metres and more, and that the collected colors of deep water were seen on a black ground. But, in the light of the recent deep-sea investigations, this idea must be given up, along with the other one that once prevailed, that there is no animal life in great depths. Most animals living in dark caves have atrophied or no eyes; there are also living beings found on the surface of the earth, which hide themselves in dark places, under the ground, etc., and are blind. Similar conditions prevail in the great deeps. There are blind crustaceans there, which probably live in the mud and under stones, while others, moving animals, fishes, have large, well-formed eyes. It must be that they see, or in other words that there is light there. Whether this light is produced in the depth by means of the phosphorescent organs which many of these animals, even fishes, possess, or whether it penetrates from above, as might perhaps be concluded from the fact that some of the deep-sea animals whose organization compels them to creep on the ground have yellow and red colors on their backs, is of no importance so far as our inquiry is concerned. We can only reach the inevitable conclusion that we see the colors of water not on a dark or black ground but on one that is illuminated, if but faintly. This is of moment because, in the light of it, particles floating in water are illuminated not from above only, but from below too.

We can satisfy ourselves of the effects of the coarser floating matter of sand and mud, as well as of the fact that the color of masses of water depends to a large extent upon the color of such matter. The Arve, which flows in front of my windows, is grayish yellow in summer, and opaque, assuming a deeper color after rain-storms; in winter, on the contrary, it is green, semi-transparent, and greener and clearer the less water it carries; facts easily explainable upon principles which one of my pupils nearly established by observations continued through a whole year. In summer the Arve carries, with the surplus glacier-water, grayish-yellow fragments of the mountain rocks in great multitudes; after heavy rains, masses of yellow mud are added to these, having been washed away from the banks of the stream. In winter the amount of sediment derived from the glaciers is small, and the blue color of the water is transformed into the green mixed color. Every glacial stream has its individual color, derived from the disintegrated rocks; and it is not without reason that the two rivers which join at Zweilütschine, in the Bernese Oberland, are known as the Black and the White Lütschine. The one brings disintegrated white limestone, the other the emery of pulverized dark slates.

How extraordinarily strong the mixed colors produced by sedimentary matter may appear was shown me by an observation which I made at Nice at the end of December, 1889. The weather had been fine for a few days, and the sea, which I overlooked from my window to Cape Antibes, about fifteen kilometres away, had been unusually blue. Now came stormy weather, with sporadic showers in the mountains of the Var. The river, whose mouth is about six kilometres from my house, poured considerable masses of saturated ochre-colored water into the sea, and there was a sharp boundary of waves between the clay-yellow tongue which continually licked itself farther into the sea, and the deep-blue salt water. After a few hours the yellow tongue became bordered with a widening green band, so brightly, so poisonously green, that I was induced to apply my whole stock of green (vert Paul Veronese) to the completion of a study on which I tried to fix the phenomenon as truly as possible. Under the blowing of the west wind the tongue stretched itself out farther, to the rocky shore behind the harbor of Nice, around toward the bay of Villafranca; and when I visited the latter place the next day the water appeared, not steel-blue as usual, but green, fully green; and the fishermen of the zoölogical station there complained that no marine animals could be found swimming around, because they had fled from the green water. The blue color returned after a few days. The green was produced by the finer yellow floating matter; the coarser particles had already sunk.

The finer matter keeps afloat for a very long time. G. Bischof put some of the flood waters of the Rhine in large casks, and deposited these in the cellar of the chemical laboratory at Bonn. The finer particles had not yet entirely settled, and the water had not become clear, after several months of absolute stillness. It is plain that in a lake, in which the continual inflow and outflow keep up a constant current, though it be slight and unremarked by ordinary observers, fishermen and rowers, these fine floating particles will never come to rest, and that, since they have a yellow color, this will appear more intense in the deeper parts, because a larger number of yellow particles are floating in the thicker layers of water there. But, farther away, the shades which the floating matters of single brooks and rivers exhibit vary endlessly between gray, yellow, and reddish, and there result the most diversified and delicately shaded mixed colors, with constant variations according to the quantity of floating matter that is carried into the water-basin. Also in the sea, which is never quiet, the fine floating matter keeps afloat for a long time, and is distributed over immensely large surfaces.

Organic matters, plants and animals, have effects similar to those of mineral substances. The shores are covered with numerous plants; they grow on the lakes in all stages of green and brown (many microscopic plants, which cover the rocks as with a slime, are yellow or brown); green plants grow on the sea-shores to a depth of thirty metres, yellow and red sea-weeds to a still greater depth, forming semblances of woods and meadows, and mingling their colors with those of the water. Even in northern seas there are numerous stationary animals, sponges, solens, mussels, masses of which develop a definite color; while visitors to southern seas are unable to say enough of the splendid colors conjured up by the coral reefs.

But even this is not all. All lakes and seas swarm with swimming or "pelagic" plants and animals. Green and yellow, one-celled, microscopic algæ are exceedingly common to a considerable depth; and green and yellow algæ sometimes come to the front in such masses that "the Red Sea" becomes no arbitrary designation, but the correct expression of an observed fact. I have seen the bay of Villafranca colored partly red by millions of swimming *Anchinia rubra* about as large as peas; I have seen mile-long strips, several metres broad, immediately along the shore on the Riviera, colored a deep royal blue by compressed masses of swimming salleemans (*Velella spirans*).

We can not absolve the transparent swimming water-organisms, from the larger medusa down to the infinitesimal microbes, from having a certain amount of influence on the color of water. We should not be able to see their crystal-clear bodies if they did not refract the rays of light in a different direction from the surrounding water. By this means they send out a multitude of refracted rays, which singly are of little importance, but in the aggregate must produce an effect through their accumulation when millions of these living beings are crowded into a cubic millimetre. To what purpose should we have in some parts of the retina of our eye a million of sensitive elements or rods to the square millimetre, if we could not seize single impressions and unite them into a view of the whole?

Finally, we will not forget the air that is mixed with the water. If we shake a viscous fluid in the air, it becomes whitish, and at last white, like milk. Yet the fluid and the air are both transparent. But the air-bubbles scattered through the water refract the light in another way. The wave looks whitish, quite white on its edges, from the inclosed air, and as the motion grows stronger the white becomes more prominent, with a greenish tone when the water is clear and the sky clouded, radiant yellow in sunshine, and clay-yellow when the water is not clear. All these tones mix with the colors of the deep, and with the mirror-colors of the surface. Thus the question of the causes of the colors of water rises to be one of the most complex problems of science as well as of art, the full solution of which has not yet been reached, in spite of the various efforts of men of science and of pictorial artists, because in order to meet the apprehension of the common eye they have to continue into a picture the endlessly changing colors and shapeless figures which the sea affords. But when I stand before a wave painted by Mazure in Paris (he is there usually called *Mazure le Vague*, the Wave-Mazure), and see how that artist, without help of shore, walls, buildings, or ships, which support the eye by their forms, shows me a wave from the sea with its reflected and refracted colors harmoniously mingled with the bottom tints issuing from the deep and with the proper color of the water itself, my arms, as they say, fall from my body. And it is then hard for me to realize that the colors of water in general are composed of a multitude of factors, among which the most important are the normal blue of pure water, the mirror-colors of the surface, the refracted colors of the moving parts, the proper colors of bodies swimming in the water, and the colors of the bottom or of only very softly illuminated parts shining up through the mass.

In this, as in everything, the principle is true that there are no simple phenomena in Nature, but that all are only the result of a number of single factors, the aggregate effect of which we observe and perceive with a very imperfect instrument—our eye. —*Translated for The Popular Science Monthly from Die Gartenlaube.*

THE ANIMAL VIEW OF MAN.

ONE of the most curious and unconsciously paradoxical claims ever advanced for man in his relation to animals, is that by which M. Georges Leroy, philosopher, encyclopedist, and *lieutenant des chasses* of the Park of Versailles, the vindicator of Buffon and Montesquieu against the criticisms of Voltaire, explains in his Lettres sur les Animaux the intellectual debt which the carnivorous animals owe to human persecution. He pictures with wonderful cleverness the development of their powers of forethought, memory, and reasoning which the interference of man, the enemy and "rival," forces upon them, and the consequent intellectual advance which distinguishes the *loup jeune et ignorant* from the *loup adulte et instruit.* The philosophic *lieutenant des chasses* had before long ample opportunities for comparing the "affinities" which he had discovered between civilized man and "instructed" wolves, in the experiences of the French Revolution; but without following his fortunes in those troublous times for game-preservers, we may perhaps return to the question of the natural relation of animals to man, which, as pictured by Rousseau to prove his *a priori* notions of a state of nature, so justly incurred the criticism of the practical observer and practiced writer, M. Georges Leroy.

That man is, generally speaking, from the animal's point of view, an object of fear, hostility, or rapine, is to-day most unfortunately true. But whether this is their natural relation, and not one induced, and capable perhaps of change, is by no means certain. Savage man, who has generally been first in contact with animals, is usually a hunter, and therefore an object of dislike to the other hunting animals, and of dread to the hunted. But civilized man, with his supply of bread and beef, is not necessarily a hunter; and it is just conceivable that he might be content to leave the animals in a newly discovered country unmolested, and condescend, when not better employed, to watch their attitude toward himself. The impossible island in The Swiss Family Robinson, in which half the animals of two hemispheres were collected, would be an ideal place for such an experiment. But, unfortunately, uninhabited islands seldom contain more than a few species, and those generally birds, or sea-beasts; and in newly discovered game regions, savage man has generally been before us with his arrows, spears, and pitfalls. Some instances of the first contact of animals with man have, however, been preserved in the accounts of the early voyages collected by Hakluyt and others, though the hungry navigators were generally more intent on victualing their ships with the unsuspecting beasts and birds, or on noting those which would be useful commodities for "trafficke," than in cultivating friendly relations with the animal inhabitants of the newly discovered islands. Thus, we read that near Newfoundland there are "islands of birds, of a sandy-red, but with the multitudes of birds upon them they look white. The birds sit there as thick as stones lie in a paved street. The greatest of the islands is about a mile in compass. The second is a little less. The third is a very little one, like a small rock. At the second of these islands there lay on the shore in the sunshine about thirty or forty sea-oxen or morses, which, when our boat came near them, presently made into the sea, and *swam after the boat.*" Curiosity, not fear or hostility, was, then, the emotion roused in the sea-oxen by the first sight of man. The birds, whales, and walruses in the Wargate Sea and near Jan Mayen's Land were no less tame, and the sea-lions in the Southern Pacific, the birds that Barents first disturbed in Novaya Zembla, and even the antelopes which the early explorers encountered in the least-inhabited parts of central South Africa, seem all to have regarded the newly discovered creature, man, with interest and without fear. Sir Samuel Baker, in his Wild Beasts and their Ways, remarks on the "curious and inexplicable fact that certain animals and birds exhibit a peculiar shyness of human beings, although they are only exposed to the same conditions as others which are more bold." He instances the wildness of the curlew and the golden plover, and contrasts it with the tameness of swallows and wagtails. The reason does not seem far to seek. The first are constantly sought for food, the latter are left undisturbed. Perhaps the best instance of such a contrast is that of the hawfinch and the crossbill, birds of closely allied form and appearance. The hawfinch, which is probably the shyest of English small birds, seems to have acquired a deep mistrust of man. But the crossbills, on the rare occasions when they descend from the uninhabited forests of the North into our Scotch or English woods, are absolutely without fear or mistrust of human beings, whom they see very probably for the first time. When animals do show fear on first acquaintance, it is probably due, not to any spontaneous dread of man as man, but because they mistake him for something else. "Nearly all animals," says Sir Samuel Baker, "have some natural enemy which keeps them on the alert, and makes them suspicious of all strange objects and sounds that might denote the approach of danger": and it is to this that he attributes the timidity of many kinds of game in districts where they "have never been attacked by firearms." A most curious instance of this mistaken identity occurred lately when Kerguelen Island was visited by H. M. S. Volage and a party of naturalists and astronomers, to observe the transit of Venus. There were large colonies of penguins nesting on the island, which, though the place is so little frequented by man, used at first to run away up the slopes *inland* when the sailors appeared. They apparently took the men for seals, and thus took what appeared the natural way of escaping from their marine enemies. They soon found out their mistake, for it is said that "when they became accustomed to being chased by men"—an experience for which the sailors seem to have given them every opportunity—"the penguins acquired the habit of taking to the water at the first alarm." In another colony, the nesting females would settle down peacefully on their eggs if the visitors stood still. "The whole of this community of penguins (they numbered about two thousand) were subsequently boiled down into 'hare-soup' for the officers and men of H. M. S. Volage," writes the Rev. A. E. Eaton, "and very nice they found it." We may compare with this destruction of the penguins, the letter of Hakluyt on the voyage to Newfoundland by Antony Parkhurst, describing with high approval the business facilities for the fishing trade offered by the tameness of the great auks—called "penguins" in the passage: "There are sea-gulls, musses, ducks, and many other kinds of birdes store too long to write about, especially at one island named 'Penguin,' where we may drive them on a planke into our ship as many as shall lade her. These birds are also called penguins, and cannot flie; there is more meat in one of them than in a goose. The Frenchmen that fish neere the Grand Bank doe bring small store of flesh with them, but do victuall themselves alwayes with these birdes."

The point of view from which the lion or tiger looks on man is perhaps not so far removed from that of the non-carnivorous creatures as might be supposed. Man is certainly not the natural food of any animal—except of sharks and alligators, if he is so rash as to go out of his native element into theirs—and if the item "man" were subtracted from the bill of fare of all the carnivora, they would never want a meal. The notion of the natural attitude of a lion to a young lady—

> "When as that tender virgin he did spye,
> Upon her he did run full greedily,
> To have at once devoured her tender corse,"

is still popular, but hardly correct. More probably the lion would get out of the way politely—if we may judge by the pacific behavior of those in our last-explored lion-haunt, Mashonaland. M. Georges Leroy's contention for the natural affinity, or semi-sympathy, which should exist between man and the intelligent hunting animals is no doubt partly reasonable. Leigh Hunt was unpleasantly struck by the *incongruity* of the notion of being eaten by a wild beast—"the hideous *impracticable fellow-creature,* looking one in the face, struggling with us, mingling his breath with ours, tearing away scalp or shoulder-blade." But the "fellow-creature" is not nearly so impracticable as he is supposed to be. More human beings are probably killed by tigers than by any other wild beast, except by starving wolves. Yet this is what Sir Samuel Baker has to say on the subject: "There is a great difference in the habits of tigers. Some exist upon the game in the jungles. Others prey especially upon the flocks belonging to the villagers. A *few* are designated 'man-eaters.' These are sometimes naturally ferocious, and having attacked a human being, *may* have devoured the body, and thus acquired a taste for human flesh; or they *may* have been wounded on more than one occasion, and have learned to regard man as a natural enemy. But more frequently the 'man-eater' is a very old tiger, or more probably tigress, that, having hunted in the neighborhood of villages and carried off some unfortunate woman, has *discovered* that it is far easier to kill a native than to hunt jungle game." As a rule, the tiger is only anxious to avoid men; and it is noticed that in high grass tigers are more dangerous than in forests, because in the former they can not be seen, neither can they see, until the stranger is close upon them. An ancient instance of the opposite behavior is that recorded of the new colonists of Samaria, whom the lions attacked, and "slew some of them." A curious inversion of this experience occurred when the islands in the Brahmaputra, which were swarming with tigers, were first cultivated. The natives, mainly by the aid of traps set with a bow and arrow, killed off the tigers so fast that the skins were sold by auction at from eight annas to one rupee apiece. In this case, the tigers were the first aggressors by carrying off cattle. But it seems evident that there exists no *a priori* reason, founded in natural antipathy, why man and animals, if we could reconstruct a "state of nature" in which we could put civilized, not savage man, should not dwell together in profound peace, or at least in such peace as obtains between accidental neighbors. The only ground for quarrel that seems inevitable is the everlasting one between the shepherd and the wolf; and that, after all, is a question not of prejudice, but of property.—*The Spectator.*

SKETCH OF WILLIAM HUGGINS.

DOCTOR HUGGINS is one of the leaders in the modern methods of astronomical research, and his name is associated with a considerable proportion of the discoveries that have been made respecting the constitution of the sun, stars, and nebulæ, and with the results in general of the application of physical investigations and of spectroscopic observation in particular to the heavenly bodies.

William Huggins was born in London, February 7, 1824. He received his early education in the City of London School, and continued his studies in mathematics, the classics, and modern languages under private tutors. He devoted much time to experiments in natural philosophy, and by the aid of the apparatus which he collected he gained practical knowledge of the elements of the chief branches of physical science, including chemistry, electricity, and magnetism. He also studied, using the microscope, animal and vegetable physiology, and became in 1852 a member of the Microscopic Society. He developed a particular interest in astronomy, and, "under great difficulties," says one of the earlier biographies in Men of the Time, while still residing in the metropolis with his parents, "observed the planets and some of the double stars between the chimneys of London." The erection of an observatory in 1855, at his residence at Upper Tulse Hill, which he supplied with good instruments, gave him better opportunities for observation; and in 1858 he had an Alvan Clark telescope of eight inches aperture, mounted equatorially. He occupied himself here for some time with observation of double stars, and with careful drawings of the planets Mars, Jupiter, and Saturn. In the light of the knowledge gained in his physical studies he was not satisfied to follow in the beaten track of observation, but sought to broaden the field of study, and inquire as far as possible into the physical qualities of the sun and stars. A means of conducting investigations of this kind, which his predecessors had not possessed, was offered in the method of spectrum analysis discovered by Kirchhoff; and he was first able to undertake the application of this method in the beginning of 1862. In preparation for the research he mapped the spectra of twenty-six of the chemical elements, publishing the results of his labors in the Philosophical Transactions of the Royal Society. In conjunction with Dr. William Allen Miller, he compared the spectra of some fifty stars with those of several terrestrial elements, and found that the stars are hot bodies, similarly constituted with our sun, and containing many of the substances found on the earth. In 1864 he and Prof. Miller reported to the Royal Society the results of their observations of the spectra of the planets Venus, Mars, Jupiter, and Saturn; but they had found the light from Uranus too faint to be satisfactorily examined with the spectroscope.

The study of Uranus was resumed with an improved telescope in 1871 by Mr. Huggins, and he found its spectrum to be continuous so far as the feebleness of its light permitted it to be traced, or from C to near G. A photograph of the spectrum of Sirius was obtained by Mr. Huggins and Prof. Miller in 1863, when observations were suspended. They were resumed by Mr. Huggins in 1876, with apparatus so arranged that the spectrum of the sun could be taken on the same plate, and this method was applied to other bright stars. After recording in his communication to the Royal Society his expectation, with apparatus then under construction, of obtaining finer lines which might be present in the stellar light than those that had been seen, and of extending the photographic method to stars that were less bright, Prof. Huggins referred in general terms to "the many important questions in connection with which photographic observations of stars may be of value." Another paper recording the progress of these investigations to the end of 1879 named thirteen bright stars, Venus, Mars, and Jupiter, and different small areas of the moon, to which the method had been applied. Six of the spectra belonged to stars of the white class, while Arcturus seemed to present a spectrum "on the other side of that of the sun in the order of changes from the white-star group." The photographs of the planets showed no sensible planetary modification of the violet and ultra-violet parts of the spectrum. The results of the photographs of lunar areas taken under different conditions of illumination were negative as to any absorptive action of a lunar atmosphere. The author was then preparing to attempt to obtain by photography any lines which might exist in the violet and ultra-violet spectra of the gaseous nebulæ. He further pointed out "the suitability of the photographic method of stellar spectroscopy, first inaugurated by his researches, to some other investigations, such as differences which may present themselves in the photographic region in the case of the variable stars, the difference of relative motion of two stars in the line of sight, the sun's rotation from photographic spectra of opposite limbs, and the spectra of the different parts of a sun-spot." The British Association address of 1891 includes a fine summary of the results to date of observations of this character as they bear upon the evolutional order in which in this paper he arranged the stars from their photographic spectra. Substantially the same order had been proposed by Vogel in his classification of the stars in 1874.

Dr. Huggins presented a paper on his examination of the great nebula in Orion in 1868, and referred in it to earlier observations. The discussion was continued in 1872, and in 1882, when the author threw out the suggestion of a hope that the further knowledge of the spectra of the nebulæ afforded us by photography might lead, by the help of terrestrial experiments, to more definite knowledge as to the state of things existing in those bodies. In communications to the French Academy of Sciences and to the Royal Society in 1889 he considered it probable that nebulæ yielding a spectrum of luminous rays, with a very faint continuous spectrum, which is probably formed in part by luminous rays in close proximity, are at or near the beginning of the cycle of their celestial evolution. "They consist probably of gas at a high temperature and very tenuous, where chemical dissociation exists, and the constituents of the mass, doubtless, are arranged in the order of vapor density. As to the conditions which may have been anterior to this state of things the spectroscope is silent. We are free, so far as the spectroscope can inform us, to adopt the hypothesis which other considerations make most probable. On Dr. Croll's form of the impact theory of stellar evolution, which begins by assuming the existence of stellar masses in motion, and considers all subsequent evolutional stages to be due to the energy of this motion converted into heat by the collision of two such bodies, these nebulæ would represent the second stage in which these existing solid bodies had been converted into a gas of very high temperature. They would take the same place, if we assume, with Sir William Thomson, the coming together of two or more cool, solid masses by the velocity due to their mutual gravitation alone. I pointed out in 1864 that the gaseous nature of these bodies would afford an explanation of the appearance of flat disks without condensation which many of them present. . . . In other gaseous nebulæ strong condensations are seen, and a stronger 'continuous' spectrum. The stage of evolution which the nebula in Andromeda represents is no longer a matter of hypothesis. The splendid photograph recently taken by Mr.

Roberts of this nebula shows a planetary system at a somewhat advanced stage of evolution; already several planets have been thrown off, and the central gaseous mass has condensed to a moderate size as compared with the dimensions it must have possessed before any planets had been formed." In 1891, after more definitely describing the appearance of Mr. Roberts's photograph, he said that "to liken this object more directly to any particular stage in the formation of the solar system would be 'to compare great things with small,' and might be indeed to introduce a false analogy; but, on the other hand, we should err through an excess of caution if we did not accept the remarkable features brought to light by this photograph as a presumptive indication of a progress of events in cosmical history following broadly upon the lines of Laplace's theory."

Dr. Huggins's spectrum observations on comets, in connection with those of other observers, satisfied him of the existence of different types, and that the same comet might present on one occasion one spectrum and on another the other spectrum; that they shine partly by reflected solar light and partly by their own light, the spectrum of which indicates the presence in the comet of carbon, possibly in combination with hydrogen. In the case of the Wells comet of 1882, he remarked that as Prof. A. Herschel and Dr. Von Konkoly had showed long before that the spectra of the periodic meteors are different for different swarms, it was not surprising that we now had a comet the matter of the nucleus of which under the sun's heat showed an essential chemical difference from the long series of hydrocarbon comets which had appeared since 1864. The spectrum of Coggia's comet (1874) indicated an approach to the earth of forty-six miles per second, while the real velocity of approach was only twenty-four miles per second. It was uncertain whether the whole or part of the difference in the velocity was due to the motion of the matter within the comet. It seemed probable, therefore, that the nucleus was solid, heated by the sun, and throwing out matter which formed the coma and tail; and part of this was in a gaseous form, giving the spectra of bright lines. The other portion existed probably in small incandescent particles; the polariscope showing that certainly not more than one fifth of the whole light was reflected solar light. In a paper on Photographing the Solar Corona without an Eclipse, Prof. Huggins spoke, in 1882, of problems of the highest interest in the physics of our sun connected with the varying forms of the coronal light which seemed to admit of solution only on the condition of its being possible to study the corona continuously, and to confront its changes with other visible phenomena presented by the sun. The spectroscopic method of viewing the prominences failed; experiments in looking at the corona through screens of colored glass or other absorptive media had not been satisfactory. The author had therefore undertaken to use photography, and had satisfied himself that under certain conditions of exposure and development, a photographic plate could be made to record minute differences of illumination existing in different parts of a bright object, which was so subtle as to be at the very limit of the power of recognition of a trained eye, and even, perhaps, of those that surpassed that limit. Describing his apparatus and method, he showed that it was possible, by isolating through properly chosen absorbing media, the light of the sun in the violet part of the spectrum, to obtain photographs of the sun surrounded by an appearance distinctly coronal in its nature. He afterward found that, by using plates sensitive to violet light only, it was possible to do away with absorbing media and remove the difficulties that occurred in sifting the light. In 1886 Dr. Huggins accounted for his failure to obtain in England, since the summer of 1883, photographs showing satisfactory indications of the corona, by the existence in the atmosphere since the autumn of 1883 of finely divided matter which caused an abnormally large amount of glare. Mr. Ray Woods had met the same trouble in Switzerland in the summer of 1884.

In his British Association address, 1891, Prof. Huggins repeated a conclusion which he had expressed in 1885, that the corona is essentially a phenomenon similar in the cause of its formation to the tails of comets—consisting for the most part of matter going from the sun under the action of a force, possibly electrical, which varies as the surface, and can therefore in the case of highly attenuated matter easily master the force of gravity even near the sun—as according with the lines along which thought had been directed by the results of subsequent eclipses.

In the early part of 1868 Prof. Huggins presented to the Royal Society some observations on a small change of refrangibility which he had remarked in a line in the spectrum of Sirius as compared with a line of hydrogen, from which it appeared that the star was moving from the earth with a velocity of about twenty-five miles a second, if the probable advance of the sun in space were taken into account. The thought of discovering motion in this way was not wholly new, though Prof. Huggins was the first to apply it in practice. The Rev. John Mitchell, of the Royal Society, presented an ingenious paper, in 1783, On the Means of discovering the Distance, Magnitude, etc., of the Fixed Stars, in Consequence of the Diminution of the Velocity of their Light, in which he suggested that by the aid of a prism "we might be able to discover diminutions in the velocity of light as perhaps a hundredth, a two-hundredth, a five-hundredth, or even a thousandth part of the whole." Doppler had also, in 1841, suggested that on the same principle on which a sound should become sharper or flatter if there were an approach or a recession between the ear and the source of the sound would apply equally to light; and Fizeau, about eight years later, had pointed out the importance of considering the individual wave-lengths of which white light is composed. Prof. Huggins was not able to continue his observations of this feature till 1872, when, having devised a trustworthy apparatus, and enjoying favorable weather, he applied his method to fourteen stars which were found to have a motion of approach and twelve which appeared to be receding. He remarked upon these results that the velocities of recession or approach assigned to the several stars by him represented the whole of the motion in the line of sight existing between them and the sun. As we know that the sun is moving in space, a part of these observed velocities must be due to the solar motion. He had not attempted to make this correction, because, although the direction of the sun's motion seemed to be satisfactorily ascertained, the velocity with which it was advancing rested on suppositions more or less arbitrary. It would be observed that, speaking generally, the stars which the spectroscope showed to be moving from the earth were situated in a part of the heavens opposite to Hercules, toward which the sun was advancing; while the stars in the neighborhood of that region showed a motion of approach. There were some exceptions to this general statement; and there were some other considerations which appeared to show that the sun's motion in space is not the only, or even in all cases the chief, cause of the observed proper motions of the stars. There could be little doubt that in the observed stellar movements we have to do with two other independent motions, namely, a movement common to certain groups of stars, and a motion peculiar to each star.

Pertaining to other subjects than spectroscopic astronomy on which Prof. Huggins has written, we notice a communication to the Royal Society On the Function of the Sound-post, and on the Proportional Thickness of the Strings of the Violin. A curious letter from him in Nature, in 1873, relates the case of a family of dogs the members of which had inherited an antipathy to butchers' shops and butchers. Some of them could not be induced to pass by a butcher's shop; others showed great uneasiness in the presence of a butcher, although they could not see him; and one of them attacked a gentleman visiting his master, whose business was that of a butcher. In 1872 Dr. Huggins edited and annotated an edition of Schellen's Spectrum Analysis in its Application to Terrestrial Substances and the

Physical Constitution of the Heavenly Bodies, translated by Jane and Caroline Lassell.

Dr. Huggins was elected a Fellow of the Royal Society in 1865, and has received two of its medals; he was awarded, with Dr. Miller, the gold medal of the Royal Astronomical Society in 1867, for their conjoint researches, and he was given a second medal of the same society in 1885. He has received doctor's degrees from the Universities of Cambridge, Oxford, Edinburgh, and Trinity College, Dublin; and he holds the honors and memberships of other British societies, and of numerous societies in foreign lands. As Rede lecturer at the University of Edinburgh, in 1869, he gave an account of his researches in astronomy by means of the spectroscope; and as President of the British Association in 1891 he delivered an inaugural address, the more definite purpose of which, as defined by the author, was "not to attempt a survey of the progress of spectroscopic astronomy from its birth at Heidelberg in 1859, but to point out what we do know at present, as distinguished from what we do not know, of a few only of its more important problems." The success of this effort, the Observatory says, was recognized equally by the general public and by those more familiar with astronomy. "Those who were already familiar with Dr. Huggins and his work have learned afresh almost to their surprise how closely he has been identified with the 'very remarkable discoveries in our knowledge of the heavens which have taken place during this period of thirty years.' Not that the president materially assists in pointing this moral; rather is it pointed by the facts in spite of him. He is almost too eager to assign credit to others when he might justly have mentioned his own work."

The manufacture of flints is still carried on at the hamlet of Porcharioux, department of Loir-et-Cher, France, where the stone is abundant and of fine quality. The stones are quarried and roughly broken by the men, and are taken by the women into the house to be finished. A single worker can dress five or six thousand stones in a week. The use to which the flints are applied is not known to M. Belot, who has described the manufacture; but the business seems to be profitable. The work is attended with danger of lung disorders caused by the dust, a liability which the workers accept philosophically. The business is in the hands of a single family.

A recent investigation by Mr. Thomas Whitelegge, of Sydney, may cast some light as to the causes which influence marine food supplies. He found that a sudden discoloration of the water in Port Jackson Harbor was caused by the presence of a minute organism which he identified as a species of the genus *Glenodinium;* and, so far as he was able to judge, fully half of the shore fauna was destroyed by the invaders. The bivalves were almost exterminated wherever the organism was abundant during the whole of the visitation.

EDITOR'S TABLE.

THE "AMERICAN EXPERIMENT" IN EDUCATION.

STATE Superintendent of Education Andrew S. Draper lately delivered an address on education before certain teachers' associations. He also lately made a report on the same subject to the Legislature of New York. In the address he spoke of the "stern logic of the American experiment" having forced free schools upon the countries of Europe. What the stern logic of the American experiment teaches we are ourselves not prepared to say; but we notice that, in his annual report, Superintendent Draper tells us that one result of the American experiment is that since 1851 there has been a steady decrease in the percentage of attendance at the public schools. These are his words:

"The reports show that in 1851 the 'total attendance' comprised 75·6 per cent of the school population. This percentage has constantly fallen off with surprising regularity during the intervening forty years. In 1861 it was 65·6 per cent, in 1871 it was 68·4 per cent, in 1881 it was 61·4 per cent, and in 1891 it was 57·8 per cent. This is a showing which must engage the attention of all thoughtful persons. There should be some explanation of it, or there should be vigorous measures to remedy the growing evil of non-attendance upon the schools. Is there any explanation? Are the circumstances as unfortunate as the figures indicate? It should be said, in the first place, that the 'school population,' being all between five and twenty-one years, includes many children whose parents deem them too young to go to school, and a great many more who have gone through the schools and commenced work. In other words, the statutory school age is both younger and older than the actual school age is, or ever can be, in the greater number of cases, and is therefore misleading. This will indicate why the percentage is small, but not why it continually grows smaller."

The fact is that, since the establishment of kindergartens, children are going to school at a younger age now than they did a generation ago; and it is also the case that boys and girls stay longer at school nowadays than they used to do; so that, in the absence of other influences, the percentage of attendance ought to be higher considerably than it was in 1851. Perhaps it was that forty years ago people had not yet learned to undervalue education on account of its very cheapness. Whatever the explanation, it seems to us that "the logic of the American experiment" requires to be further explored.

THE LAW AND THE DOCTORS.

MR. FREDERIC HARRISON and Mrs. Fawcett have been having a little controversy of their own on the subject of "the emancipation of women." Mr. Harrison is desirous that women should have all possible educational advantages, and he says many fine things about their intellectual and moral powers; but he still holds that their place is in the home, not in the factory, the counting-house, the Government office, or the political meeting. Mrs. Fawcett points out the impossibility of confining women to the home in these days when so many of them have no home, or none that can give them a living; and, apart from that, she resents the idea that women are not adapted to extra-domestic tasks and duties. The controversy is in able hands, and we have no wish to intervene at present. One remark that Mrs. Fawcett makes, however, seems to call for a word. She speaks of "people who are in rebellion against all order in society; who think marriages should be dissolvable at will; that parents ought to have no control over their children," and so on through quite a list of absurdities, the last being the opinion that "any quack or impostor who chooses to put a brass plate on his door calling himself a physician, a lawyer, or what not, should occupy exactly the same position as those who have entered the various professions after complying with the constituted educational test of fitness." Now, we are not acquainted with any persons, nor have we heard of any, who hold this opinion; but we do know of some who consider that if there is anything that tends to bring the capable man and the ignoramus down to a common level, it is the brass door-plate under existing conditions. The public understand now that they have a guarantee that the M. D. on a door-plate or diploma means something definite; whereas the fact is that it may cover the widest possible diversity of attainments and abilities. The present system casts a kind of mysterious sanctity round the very blunders of the authorized physician, so that good wives may be heard talking of them with bated breath almost as if they were treading on holy ground. The doctor in fact is treated in general with far more consideration and even reverence than the minister, and, so far as we can see, his science only suffers through the distinction made in his favor. Whatever Mrs. Fawcett may think of it, we are strongly of opinion that medical science will never make the progress it is capable of till it is wholly set free from state control. Instead of such freedom placing the impostor and the competent practitioner on a level, it is the very thing, we are persuaded, that would do most to drive impostors, certified and non-certified, out of the "profession."

LITERARY NOTICES.

Moral Teachings of Science. By Arabella B. Buckley (Mrs. Fisher). New York: D. Appleton & Co. Pp. 122. Price, 75 cents.

Science has been many times accused of having no tendency toward morality, and, in fact, of exerting an opposite influence by releasing men from some restraints that formerly held them to the path of virtue. It is true that the adherents of science have not yet been able to construct a complete system of ethics, based on the evolution philosophy, but their position has been that of a builder who is jeered at because his house has no roof before he has had time to raise its walls in the face of the hindrances thrown in his way by his critics. The old conception of the universe is a growth of tens of centuries; must the new be thoroughly worked out in a single generation? However, scientists have no disposition to shirk the ethical problem, and now that they have achieved a suitable vantage-ground are already beginning to develop a solution of it. The present volume is designed to show in a simple manner that science *does* tend to produce moral conduct, and how its moral teachings are to be looked for. The author affirms at the outset that acquaintance with scientific truth can not give us false guidance with respect to conduct. If selfishness is not the universal law of progress, she says, "we need have no fear that the study of natural laws will mislead us into believing it. With our limited knowledge we may often be perplexed, but so long as we do not overstrain the facts we shall not be confounded. If it be true that the instincts which lead us to be just and merciful, honest and unselfish, pure and affectionate, to fear moral degradation, and to aspire to nobleness of character, are inherent in the very laws of our being, then we shall find the gradual development of these qualities in the groundwork of living nature. In a word, we shall find evidence that high moral duties are not true merely because all religions have taught them, but that all religions have taught them because they are true."

The author admits no question as to the existence of God, but declares that his "*ultimate* nature and attributes" "must transcend our utmost efforts of intuition or imagination." Yet, she continues, "we can not surely fail to recognize that partial manifestations of that nature are taking place within and around us at every moment of our lives." Science has revealed how the First Cause proceeds in the creation of a particular kind of plant or animal; it has shown, as no other testimony has been able to show, that "his ways are not as our ways," and that he is "without variableness or shadow of turning," and it has made men feel that every right or wrong act is sure to have its proper recompense. The presence of pain and strife in the world has long been a mystery. The great scientific doctrine of natural selection first gave a clew to their usefulness.

In both the animal and the vegetable kingdoms the author points out that species and individuals that satisfy the conditions of their surroundings flourish, while those that behave differently perish. From this she draws the lesson that in order to attain the highest life of which he is capable, man must adapt his conduct to the will of the Author of all things, as expressed in the laws of the universe. Although one's conduct is largely influenced by heredity, this is no excuse for resigning one's self to a downward course. From the very beginning of animal life we see a power of *choice* developing together with consciousness, and out of this power springs responsibility. The success and the enjoyment achieved by disregarding moral laws are only a short-lived success, and an imperfect enjoyment.

The question of immortality Mrs. Fisher deems a profound and difficult one. Regarding it as intimately connected with all higher morality, she feels obliged to state her conviction upon it, which is that "our moral nature and the conclusions of science, even apart from religious belief, all point to a continuation of individual existence beyond the few short years we pass in this world." The reasons that she gives in support of this opinion are not, however, as clearly teachings of science as are those which she finds as a basis of moral conduct. The chief argument is that persons who suffer inherited disadvantages in this life ought to have compensation. Thus it will be seen that the book accepts the main principles of religious ethics, and supplies reasons for obeying moral laws in addition to those which the most enlightened religions contain. Its influence on the adult or the young reader can not fail to be elevating, and it should prove to be a valuable text-book for the teaching of pure ethics.

Principles and Practice of Plumbing. By S. Stevens Hellyer. London: George Bell & Sons, 1892. Pp. 294. Price, $1.25.

This is one of the Technological Handbooks issued by the London publishers, George Bell & Sons, and edited by Sir H. Trueman Wood, Secretary of the Society of Arts. It appears to cover the subject quite completely though briefly, and contains much information that the householder would find it advantageous to know, though it is addressed primarily to the plumber. The contents of the volume range from a consideration of the metallurgy of lead and tin to the proper fixing in place of the various apparatus which it is the business of the plumber to know about.

The Elements of Politics. By Henry Sidgwick. London and New York: Macmillan & Co., 1891. Pp. 632. Price, $4.

Prof. Sidgwick has undertaken in this volume a general survey of the field of politics, with the object of determining what work a government may properly undertake to do, and what form of structure is best suited to the purpose. Holding to the individualistic view of social organization as contrasted with the socialistic, and seeking his sanctions in the main in the principle of individualism, he yet departs widely at times from the *laisser-faire* school of political thinkers. He rejects the strictly individualistic test of what things a government may properly attempt to do as being inadequate, and adopts instead the "general welfare," as the test of what things are permissible and what are not. From this point of view he is able to find adequate sanction for such extensions of government activity as public education, the care and relief of the indigent, public hospitals, public parks, sanitary supervision, etc., and the carrying on of certain businesses that are semi-public in character, such as the transmission of mails and telegrams, and the supply of water and lighting in towns.

The scope of the author's inquiry in this branch of his subject may perhaps be best indicated by the following extract:

"The legislation of modern civilized communities, then, is, in the main, framed on an individualistic basis; and an important school of political thinkers are of opinion that the coercive interference of government should be strictly limited to the application of this principle. I propose, accordingly, in subsequent chapters, to trace in outline the chief characteristics of the system of law that would result from the consistent application of the individualistic principle to the actual conditions of human life in society. I shall then examine certain difficulties and doubts that arise when we attempt to work out such a consistent and exclusive individualistic system. I shall analyze the cases in which, in my judgment, it tends to be inadequate to produce the attainable maximum of social happiness; and I shall consider to what extent, and under what carefully defined limitations, it is expedient to allow the introduction of paternal and socialistic legislation, with a view to remedy these inadequacies."

In the branch of this subject relating to the structure of a government, Prof. Sidgwick is occupied with a discussion of what he esteems the most desirable relation between the three prime departments of a governmental structure—the executive, legislative, and judicial. His discussion is well worth study, and abounds in suggestions of improvements in details as well as in principles of the more prominent features of modern governments.

The Horse. By William Henry Flower, Sc. D., Pres. Z. S., etc. Modern Science Series, No. II. New York: D. Appleton & Co. Pp. xiv + 204. Price, $1.

Prof. Ball's instructive book on The Cause of an Ice Age, which opened the new popular scientific series, edited by Sir John Lubbock, is followed by the present volume, in which the structure of the most interesting of the domestic animals is described. The author begins by defining the horse's place in nature, as indicated by its ancestors, whose fossil remains have been found in considerable abundance, and by its relatives. In the second chapter the horse and its nearest existing relatives are described. These are the Perissodactyle ungulates comprising the three families, tapirs, rhinoceroses, and horses. Of these the tapirs retain more of the primitive characteristics of the common ancestors of the three families than either of the others. Of the tapirs there is but one genus. The rhinoceroses are grouped in three sections or genera—the rhinoceros with one horn, the ceratorhinus and the atelodus, each with two. The horses (family *Equidæ*) comprise the horse proper, the asses, and the zebras. Although wild horses have been abundant in both America and Europe, the nearest approach to a wild horse existing anywhere at present is the *tarpan* of the steppes in southeastern Russia. The latter half of the volume is devoted to the structure of the horse, chiefly as bearing upon its mode of life, its evolution, and its relation to other animal forms. The bones of the head and neck and the dentition are fully described, and the chief characteristics of the lips, nostrils, and neck are pointed out. In describing the cervical ligament, which is attached like a stay-rope to the neck and to the fore part of the backbone, the author takes occasion to condemn the useless cruelty of the bearing-rein. The fourth and last chapter is devoted to the limbs, and contains an interesting comparison between the arrangement of the bones in the limbs of the horse and in those of man. Twenty-six figures illustrate the text.

Principles of Economics. By Alfred Marshall. Vol. I. Second edition. London and New York: Macmillan & Co., 1891. Pp. 770. Price, $3.

This well-known treatise of Prof. Marshall has undergone but slight changes in the present edition, the more important of which are pointed out by the author in his preface. The work is a general presentation of the science on the general lines laid down by the English economists, but there is to be traced in it the influence of more recent economic thought in modifying the treatment of many problems and altering the weight given to conditions and considerations not strictly economic. As Prof. Marshall points out, the older economists were disposed to view the science too largely from the point of view of the needs and actions of the "economic man"—an ideal construction actuated only by economic motives, instead of those of the actual man, in the determination of whose economic action many motives enter besides those that are strictly economic. Paramount among these are the ethical forces, family affections, and other altruistic feelings, which in any given set of conditions are sufficiently uniform to produce conduct that may be predicted. The introduction of considerations of this kind as economic factors, while leaving the older conclusions substantially as they were, tends to give to them much less sharpness of outline, and presents economic laws more as statements of general tendencies than as a set of fixed and invariable conditions.

The book is well printed and bound and of convenient size, and is provided with marginal notes indicating the subject-matter. An appendix concerned with the application of mathematics to economic problems, and an index complete the volume.

Manual of Chemical Technology. By Rudolf von Wagner. Translated and edited by William Crookes, F. R. S. From the thirteenth enlarged German edition as remodeled by Dr. Ferdinand Fischer. New York: D. Appleton & Co. Pp. 24 + 968. Price, $7.50.

So great have been the changes in the chemical treatment of materials in the various industries since the author's last edition of this work appeared that the present edition is practically a new book. The eleventh edition was completed by Wagner shortly before his death in 1880. The twelfth edition, which was issued in 1886, was edited by Dr. Fischer, who cut out the matter that had become obsolete, and inserted references to recent improvements in the processes treated, but made no extensive changes. In the present edition the work has been wholly remodeled; the alphabetical arrangement of the subject-matter has been replaced by a classified grouping; new subjects have been introduced, the latest developments in old subjects have been inserted, and about half the six hundred illustrations are new.

Since fuel is indispensable in every department of technology, it is first considered, over one hundred pages being given to this subject and lighting. Both the preparation and use of heating and lighting materials are considered. The greater part of this section is new matter. In Section II, Metallurgy, a new subdivision on potassium and sodium is inserted. Section III is devoted to Chemical Manufacturing Industry, including the production of sulphur, sulphuric acid, soda, explosives, ammonia, salts of the metals, etc. New topics in this section are water, manures, and thermo-chemistry. Section IV, on the Organic Chemical Manufactures, has been written entirely anew. This chapter includes alcohols and ethers, organic acids, benzol colors and other organic coloring matters, etc. The fifth section is devoted to glass, earthenware, cement, and mortar; the sixth deals with Articles of Food and Consumption; and the seventh with the Chemical Technology of Fibers, while the eighth is a miscellaneous group, comprising the products of hides, bones, and fats, the essential oils, resins, and the preservation of wood. Thermometric, hydrometric, and other tables are appended to the volume. The translation has been carefully edited by Prof. Crookes, with the omission of some passages of merely local application and the insertion of notes and bibliographical references, making the version much more valuable to English readers than a simple translation would have been.

The Working and Management of an English Railway. By George Findlay, General Manager of the London and Northwestern Railway. New York: Macmillan & Co., 1891. Pp. 354. Price, $1.50.

In this small volume of three hundred odd pages Mr. Findlay has detailed the working and management of one of the great English railways—the London and Northwestern. His description includes the financial and business as well as the mechanical operations of the road. What strikes the reader of these pages the most forcibly is the thoroughness with which all the details of operation have been worked out, and the care exercised over these details to assure the perfect operation of the road at all times. To this end the road is placed under the most detailed supervision, as well as being provided with the various modern appliances which experience has shown are essential to safety. It is, of course, operated under the block system, without which the operation of any great railroad with its multifarious traffic can not be safe. To listen to the excuses often made by railroad officials for not adopting this system, one would get the idea that it is in some way complex and intricate and not easy of application to railway operation under all circumstances. It is, however, simplicity itself. It does not consist in any necessary forms of appliance, but is simply a method of operating. Mr. Findlay describes some simple forms of indicators used on the London and Northwestern, but any form of indicator may be used. The block system consists simply in dividing a road into a number of sections and allowing but one train at a time in either direction in any given section. To apply it to a road requires only the erection of proper signals and suitable means for operating them, and knowing their condition by the operators stationed along the line at the entrance of every block division. It is a matter of no small wonder that the officials of any considerable road should resist the introduction of so simple a method of insuring safety, and that any community should tolerate a railway service not operated in such a manner. The book is very readably written, and can be read with interest by the general public who have to make use of the railways, and with profit by not a few of our railway managers.

Diseases of the Urinary Apparatus. By J. W. S. Gouley, M. D. New York: D. Appleton & Co. Pp. xiii + 342. Price, $1.50.

Criticism of the substance of this treatise must be left to that very small minority of the medical profession who are familiar with the latest contributions, made in Europe and in this country, to the author's special branch of their science. It is enough to say on this subject that Dr. Gouley has here brought into one small volume everything which the well-educated practitioner, who is not yet a specialist, needs, to set him on a level with the foremost specialist in urinary surgery and medication—except experience. The physician of a scientific habit of inquiry will find it a most stimulating book; full, indeed, of the facts of observation and practice, but with each fact set forth, not as an isolated fragment of knowledge, but as an essential part of an organic system of truth. At the same time the spirit of inquiry pervades the whole. The student of the subject is taken into partnership with the teacher in the great work of advancing the boundaries of knowledge. The dogmatism which claims finality and universality for its own formulas is excluded; and every acquisition is made a stepping-stone in the way to new discovery. One hardly knows, in ending the perusal of these pages, whether the writer is most to be congratulated as the representative of the generation of reformers, who have reconstructed this important branch of medical science and placed it on a lasting basis, or as the harbinger of their successors, who will surely, by following out the same methods to far greater results, add immeasurably to its power to serve mankind.

It is rather our province to speak of the literary form of the work, which certainly deserves special notice. Technical treatises, in every line of professional learning, are so often marked by everything that is forbidding in style that it is a rare privilege to meet with one which can be treated as literature. Of course, no such work is designed for popular reading; and this one, in particular, is addressed only to students of special education and high intelligence. But its special merit is that it is perfectly adapted to its end. There is no waste of words, no tedious repetition, no looseness of statement, no parade of impertinent learning, no obtrusion of personality. Concise in style, precise in definition, clear in reasoning, orderly and progressive in arrangement, and with an accuracy and care in terminology almost without precedent, it leads on from the elements of the subject to the very border lines of contemporary knowledge in a steady march, which offers a model in plan to all who would teach subjects of difficulty. We trust that it will receive from the profession a welcome which will be an object-lesson to many medical writers; for it would be easy to name many whose books, while containing information of great value, would be doubled in usefulness, though halved in size, if re-written after the fashion of this admirable *multum in parvo*.

Travels among the Great Andes of the Equator. By Edward Whymper. With a Supplementary Appendix, bound separately. New York: Charles Scribner's Sons. Pp. xxvi + 456, and xxvi + 147. Price, $6.

Whether regarded as a book of travel or as a record of scientific exploration, Mr. Whymper's production has eminent claims to attention. The chief object of his expedition was to investigate the physiological effects of the diminished air pressure at high altitudes. That some disturbance of the bodily functions is caused by ascending to great elevations had been established by the testimony of "multitudes of persons of diverse conditions—by cultured men of science down to illiterate peasants. . . . Nausea and vomiting; headaches of a most severe character; feverishness, hæmorrhages, lassitude, depression, and weakness; and an indescribable feeling of illness—have been repeatedly mentioned as occurring at great elevations, and have only been cured by descending into lower zones. To these maladies the term mountain sickness is now commonly applied." While such effects have been felt by persons who have slowly climbed mountains to heights of fourteen thousand to fifteen thousand feet, balloonists have often risen within an hour to much greater heights without such inconvenience. This fact gives reason to believe that symptoms produced by fatigue have been attributed often to rarefaction of the air. Accordingly, in his Andean explorations, Mr. Whymper took especial care to eliminate the effects of fatigue from his observations.

The scene of his operations was that part of the chain of the Andes crossing the Republic of Ecuador, and among the mountains climbed were Cotopaxi, on the summit of which a night was spent, and Chimborazo twice, the summit being reached only in the second ascent. Many less noted peaks also were scaled. Besides making the observations which were his chief care, Mr. Whymper determined the altitudes and the relative positions of the chief mountains of Ecuador, made comparisons of boiling-points and aneroid readings with the readings of the mercurial barometer, and made botanical, lithological, zoölogical (chiefly entomological), and archæological collections. As stated in the introduction, he concerned himself "neither with commerce nor politics, nor with the natives and their curious ways." Yet the incidents of the expedition, which are plentiful and are recounted with much vividness and humor, tell not a little about the "curious ways" of Ecuadorian bipeds and quadrupeds, likewise of hexapods and centipedes. The baggage-mules were inexhaustible mines of original sin, and the insects in the lower regions were everywhere. One full-page plate crowded with figures of flying and creeping things is described by the author as "selections from my bed-fellows at Guayaquil." The volume is copiously illustrated with carefully drawn and engraved pictures, many of them from the author's photographs. The meteorological observations are appended to the main volume. In the supplementary volume Mr. Whymper's zoölogical collections are described, with illustrations. They include a goodly number of species which were new to science.

The *Chinese Scientific and Industrial Magazine*, John Fryer, LL. D., editor, is now in its sixth volume. Its purpose is to convey to intelligent Chinese a knowledge of the principles and progress of Western science and art. It contains, quarterly, one hundred pages of matter, printed in the best Chinese style, liberally illustrated, relating to subjects of practical as well as theoretical interest. In the number before us such subjects are treated as photography, the art of living long, sugar-making, therapeutics, pressing, drawing, shearing, and stamping machinery, electricity, materia medica, ice-making machinery, the manufacture of lucifer matches, dual consciousness, electric railroads, Edison's kinetograph, and mathematical problems. Presbyterian Mission Press, Shanghai; Ralph Waggoner, 10 Spruce Street, New York. Price, $1 a year.

Dr. *John Aulde*, acting upon the belief that with the better knowledge of the physiological action of drugs large doses are not needed to produce desired clinical effects, has prepared *The Pocket Pharmacy*—a book intended both for practical use and as a plea for small doses, to be administered in accordance with physiological deductions. We are learning, he holds, instead of the gross manifestations of disease, to regard more closely the derangement of cell function on which they depend. Having acquired this knowledge by studying the pathological changes occurring in disease, we endeavor to discover remedies which, by their known physiological actions, would be calculated to arrest or counteract those changes. This leads to the study of the effect of medication on the diseased cell, and logically to the conclusion that small doses are to be preferred. The present work is the outgrowth of personal experience in practice, and it is adapted to use with the pocket case. It contains a list of remedies, with the diseases to which they are suited, and a therapeutic index of diseases with reference to the remedies prescribed for them. (D. Appleton & Co., publishers.)

A hand-book on *Chemical Calculations* (New York: Longmans, Green & Co., 60 cents) has been prepared by Mr. *R. Lloyd Whiteley*, to supply a need for a work giving, besides a fair selection of problems, a concise and yet explicit account of the methods of solving them. It is intended to form a part of the course of teaching or study suitable to the chemical student who wishes to prepare himself for whatever duties in his line he may be called upon to perform, and is also an aid to examinations. A short summary of chemical facts or processes is given before explaining methods; and the explanations concern methods of calculating the results of specific gravity determinations, of analyses of all kinds, and of atomic and molecular weight determinations, and are brought up to date. The author is a laboratory teacher and a lecturer on certain special branches of chemistry, and brings the results of his experience and of his intercourse with students to aid in his work. Prof. F. Clowes furnishes the preface.

A translation of Dr. *Walther Hempel's Methods of Gas Analysis*, made by Prof. L. M. Dennis, of Cornell University, is published by Macmillan & Co. It has been the purpose of the author, omitting the complete description of known methods, which would make the book too bulky for a laboratory guide, to describe his own researches and the construction of apparatus, and all the operations which are involved in the analysis of gases with his apparatus. The apparatus devised by Pettersson has been described because a wholly new principle in the measurement of gases is there brought into use. In the translation, which has been made with the personal co-operation of Prof. Hempel, the chapter upon the determination of the heating power of fuel has been largely rewritten, with the introduction of new cuts of the latest forms of apparatus, the chapter upon the analysis of illuminating gas has been changed, and a new method for the determination of the hydrocarbon vapors has been inserted. Price, $1.90.

In the treatise of *R. Lovett* and *C. Davison* on *The Elements of Plane Trigonometry*, the subject is divided into three parts, dealing, respectively, with arithmetical, real algebraical, and complex quantity. Such an arrangement appears to the authors to be a natural one, and has the advantage of introducing the new names and formulæ that belong to the subject before the student encounters the difficulty of the application of signs to denote the sense and direction of lines. The work differs mainly from those most generally read in the extent to which the treatment adopted by Prof. De Morgan, the influence of whose writings appears throughout it, has been followed. Abundant examples for exercise have been collected from university and other examination papers. Published by Macmillan & Co. Price, $1.60.

A book on the *Essentials of Physics* has been added to the series of *Saunders's Question Compends* (W. B. Saunders, Philadelphia), by Dr. *Frederick J. Brockney*. It has been prepared especially for students of medicine, and is intended to be a compromise between such books as Ganot's, which is found too large to be used as a text-book, and some elementary books on the subject which do not contain all that is necessary for the student to know. The questions are classified as On Matter and its Properties—Solids, Liquids, and Gases; On Heat; On Light; On Sound; and On Magnetism and Electricity. Price, $1.

Mr. *David Denning's* hand-book on *The Art and Craft of Cabinet-making* (Macmillan, $1.50) will be welcomed by amateurs and young craftsmen, and even experienced workmen may derive pleasure and profit from it. It relates to the construction of cabinet furniture, the use of tools, the formation of joints, etc., explaining the ordinary reliable methods of the workshop, but not exploiting novelties in style or processes. It marks the distinction between cabinet-making and joinery, and between cabinet-making and decoration; gives a review of the development of furniture, in which the tricks and deceits of a class of dealers in pretended antiques are exposed; and then furnishes practical information, with more than two hundred illustrations, concerning the various matters pertaining to cabinet-making—furniture woods, glue, nails, tools, wooden appliances made by the user, grinding and sharpening tools, joints, structural details, construction of parts, drawing, veneering, etc., and the construction of various articles.

Mr. *J. Traill Taylor's* manual on the *Optics of Photography and Photographic Lenses* (New York: Macmillan & Co., $1) is practical rather than theoretical, and is intended for the users of photographic lenses. It includes the substance of articles furnished to the photographic journals and photographic clubs of Great Britain. It furnishes brief accounts of the nature and properties of light, the principles on which the use of lenses is based, their defects and the means of remedying them, the different classes of lenses; the methods of preparing, mounting, fitting, and using them; and such other information as the photographer needs respecting them. The author distinguishes the optics of photography from that of the telescope or microscope by showing that the former takes cognizance of rays transmitted obliquely as well as axially, and brings both the chemical and visual rays to a focus on the same plane.

A book, small enough to be carried in the pocket and convenient for reference at any time, entitled *American Citizenship and the Right of Suffrage in the United States*, has been compiled by *Taliesen Evans*, and is published by him at Oakland, Cal. It comprises abstracts of national and State laws affecting citizenship and suffrage in the United States, and of such questions relating thereto as have from time to time been passed upon by the courts. The effort has been made to treat the subject in such a way as to make the presentation acceptable and instructive to the American student, and interesting and useful to persons of foreign birth who desire to become citizens and voters. It includes general reviews of the conditions of American citizenship and of the right of suffrage; literal quotations of the constitutional provisions of each of the States concerning the qualifications of voters; a chapter on the qualifications for holding office; and the Constitution of the United States.

The Rev. *Emory Miller*, D. D., LL. D., apparently endeavors, in a book on the *Evolution of Love*, to approach the deepest questions of divinity. Superstition, opinion, and discrimination, he says, are three epochal words, of which the first has had its day and the second its noon, while the sun of discrimination is dawning. Casting away superstition, refusing to be bound by opinions, the author tries, he says, honestly and by the method of discrimination, to seek the truth. In this spirit he discusses the Implication of Being as perceived, as conceived, and as conditioned, and finds perfection of Being in perfect love. He next discusses Creation, with the conclusion that it is an indulgence of love's eternal, altruistic spirit; finds the origin of evil in selfishness, and its solution in conditions within which it is held that provide for either its merciful remedy or its self-extinction. The last chapters relate to The Atoning Fact, The Revelation of Atoning Fact, and Eschatology, or the doctrine of "last things." Chicago: A. C. McClurg & Co. Price, $1.50.

The Bureau of Education has issued a Circular of Information on *Sanitary Conditions for School-houses*, the result of an extended study of this subject by Dr. *Albert P. Marble*, of Worcester, Mass. This monograph is concerned with practical devices for ventilation and heating, drainage and lighting. Appended to the body of the circular are papers on Ventilation of School-houses heated by Stoves, Hygienic Construction of the Bridgeport High-school Building, Worcester School Buildings, Plans and Specifications of School-houses prepared for the Wisconsin State Bureau of Education, and Designs for School-houses accepted by the Department of Public Instruction of the State of New York. The whole document is copiously illustrated; the main portion has twenty-three figures in the text and seventy-one plates, showing heating apparatus, the arrangement of ventilating ducts, the course of heated air through rooms, sanitary closets, etc. The appendixes are accompanied by eighty illustrations, showing plans and views of school-houses, and arrangements for heating and ventilating.

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POPULAR MISCELLANY.

Possibilities of Wheat-raising.—Within twenty years, according to a bulletin of the State Agricultural Experiment Station, the area annually sown to wheat in Ohio has increased from an average of 1,800,000 acres during the eighth to 2,500,000 acres during the ninth decade. This area represents twelve per cent of the area in farms within the State; but several counties are sowing annually from eighteen to twenty and even twenty-five per cent of their farm-lands to wheat. A further increase in acreage is anticipated from the clearing away of more forest and the reclamation of waste lands by drainage, so that it will be possible to devote 3,000,000 acres to wheat without interfering with any other agricultural interest. Such an increase, at the present rate of production, would represent an annual crop of 40,000,000 bushels. But it is not to be supposed that Ohio farmers will rest content with a yield of only thirteen bushels of wheat per acre. The northern third of the State has increased its average yield within forty years by nearly three bushels, and the middle third by from one to two bushels, and it is reasonable to expect a further increase within the next forty years. At the average already reached in Summit County, the whole State would produce about 60,000,000 bushels, or bread for twelve million persons. What is true of Ohio is true, to a greater or less extent, of the entire winter-wheat belt of North America. The area now sown to wheat in this region may be expanded largely without infringing upon other productions, and the rate of yield may and will be very materially increased by better husbandry, including an intelligent use of manures and fertilizers, and more thorough drainage. The profitable culture of wheat on the steep hillsides of southern Ohio appears to be hopeless. The great problem before the grower in the central belt of counties is winter-killing, but it may be partially solved by under-draining and the intelligent use of clover and manures. The influences are more generally favorable to wheat culture in the northern counties than elsewhere in the State. A general improvement in the methods of agriculture appears to have contributed more largely to the increase of the wheat crops than the use of commercial fertilizers.

Distribution of Diphtheria.—A paper by Dr. Samuel W. Abbott, Secretary of the State Board of Health, on the Distribution of Diphtheria in Massachusetts, brings out some curious results from an examination of the conditions in the several parts of the State in which the disease has prevailed during the past eighteen years. The town which suffered relatively most of all was Florida, a hilly town of small population, situated over the Hoosac Tunnel. Next to it was Spencer, an interior town of Worcester County, having a comparatively dense population (7,466 in 1880), mostly engaged in the shoe manufacture. The third town in the list was Freetown, with 1,329 inhabitants in 1880, adjoining Fall River, and situated on low and sandy ground. Other towns that suffered greatly were Adams, Williamstown, and Hancock, on high land; Webster, a manufacturing town on comparatively low land; Ayer, and Nantucket. Four towns had no deaths from diphtheria during the period under consideration. They are all small towns, distant from railroads, and not visited by the general public. Dividing the towns and cities according to the density of their population, the author found that the average annual death-rate from diphtheria and croup in ninety-two densely settled towns and cities was 11·39 per 10,000 of the population, while that of two hundred and fifty-four rural or sparsely settled towns was 6·53 per 10,000 for the same period. Out of the twenty-eight cities, twenty, including all of the most populous, except Fall River, had a death-rate from diphtheria and croup higher than the average of the State. Dividing the counties into three groups—those in which there were, respectively, $\frac{8}{100}$ of an acre, 1·4 acres, and 4·8 acres to each person, the corresponding rates of mortality from diphtheria and croup were 12·7, 10·2, and 8·8 annually for every 10,000 persons. The relation of certain railway lines to the diphtheria death-rate is worthy of note. It was comparatively high in the greater number of cities and towns traversed by the Boston and Albany Railroad—a leading road for traffic, carrying large numbers of passengers, and having many stations; was less upon the line of the Fitchburg road, which is of about the same length but does less business; and still less upon the line of the more recently built Massachusetts Central road. The term *diphtheria* first appeared in the registration reports of the State in 1858. The number of deaths assigned to it increased rapidly till 1863, when 1,420 were registered. There was then a rapid decline to 251 in 1867, after which the annual number continued nearly uniform (about 275) for seven years, when it rose again to 2,610 in 1876 and 2,734 in 1877. The census of 1890 gave the number of deaths as 32,716. The diphtheria death-rate bore no relation to the general death-rate, except during the period from 1862 to 1867. In 1872, when the general mortality-rate was at its highest point and infectious diseases were generally very prevalent, the diphtheria death-rate was far below the mean, and in 1876 and 1877, when the general death-rate was near the mean, the diphtheria death-rate was at its highest point. The author concludes, further, that diphtheria is eminently contagious; that it is infectious by direct exposure and through indirect media, but less so than some other diseases, such as small-pox and scarlet fever; that overcrowding, faulty ventilation, and filthy conditions favor its spread; that the direct influence of plumbing and transmission through public and private water-supplies is not proved; that its propagation is favored by soil moisture, damp cellars, and general dampness of houses; and that the poison may remain dormant in houses for a long period.

Scientific Observation of Children.—In a paper on this subject addressed primarily to mothers, Mrs. Helen Adler has laid out a plan of work of considerable scope, and calling for the exercise of careful judgment. Mothers, the author says, "must first of all learn to appreciate the value of true scientific observation, must train themselves to observe correctly, methodically. They must humbly learn that their own powers of appreciation are worthless without the strict selection of valuable facts, the subordination of what is interesting and delightful to them to the universally interesting and profitable. . . . Method, strict, logical method, is the first desideratum; then vigilant observation, veracity, discrimination, and ingenuity in the study of the child. Baby ways are charming and irresistible; they will be no less so when an attempt is made to discover the order of progress that dwells in them." The development of language alone is mentioned as offering a fascinating field of observation; the study of the baby will and its evolution another; and the psychic life of the child will seem somewhat nearer to us, the growth of its faculties a little more clearly revealed, if we trace the record of their development day by day. Later in life comes the development of the character of the child as a social being. A practical direction is given to these observations by appending to them a classified schedule of the points to which attention may be directed.

Olives and Olive Oil.—The olive is cultivated on about seventy thousand acres in the department of the Alps Maritimes, France, and yields a revenue of more than two million dollars a year. Two species of the tree are described by our consul at Nice as growing in the south of France: the *oleaster*, or wild olive, which has a kind of thorn and very short leaves, and produces only a few small berries, which appear to be proof against insect enemies; and the *sativa*, or cultivated olive, which produces a large fruit, and is known in several varieties. The olive tree flowers every year; but, while some growers advocate an attempt to gain a yearly crop, the majority are content to try to get a good crop every two years. Olives to be preserved green are plucked in September; those destined for oil, from November till the following May; but the best results to crop and tree seem to follow harvesting near mid-winter when the olive is black; while oil made from olives gathered as late as February and

March is preferred for its keeping properties. The mill in use at the present day to crush the olives differs but little from those which have been used for centuries. A mill has lately been invented which, as it crushes the pulp, extracts the stone and throws it out, thus allowing the pulp, the true virgin oil, to be obtained from the press without any admixture of that obtained from the stone or kernel. To prepare virgin oil, olives are taken, free from blemish, when only three quarters ripe, slightly crushed, with care that the seed be not touched by the millstone, then placed in a heap so arranged that the oil shall run out of itself and be collected. Oil thus prepared is greenish, has an exquisite perfume, and can be kept for many years. A second quality of oil is extracted by the aid of water; and after all the usual means of extracting the oil from the pulp have been employed, ten per cent of oil can still be obtained by using bisulphide of carbon. After the oil is extracted, the skins and refuse are employed in heating boilers; the muddy substance found at the bottom of the most inferior quality of oil is used as manure; and the broken stones, or *grignons*, make an excellent fuel.

The Pace of Mind.—The appearance of a new quickly calculating man, Jacques Inaudi, a Piedmontese, in Paris, has suggested the inquiry, What is the nature of the power that gives men of this kind their remarkable faculty? The Spectator suggests that such cases are abnormal instances of the difference in pace which we all know exists between the working of different and even of equal minds. "Everybody who has studied his acquaintance at all," it says, "knows that this difference is very great; that one man can comprehend an interrogation in half the time taken by another; that no two children are alike in quickness of thought, as distinguished from accuracy or depth of thought; and that clever women constantly reach results, which can only be reached by their thinking more rapidly than men." The difference is especially marked in mental arithmetic; and the difference, though it can be affected by practice or neglect, is ultimately independent of both. Inaudi was asked to mention the day of the week on which a given date would fall some years hence, and answered accurately, Monday. It is not to be supposed that he guessed, for he had done the like before, and there was no ground for assuming collusion; then "his mind must, say, in three seconds, have traversed a calculation which it would take the few men who could do it in their minds at all, many minutes. Such pace is almost unthinkable, even if we remember that, the date on which this day falls in this year being once ascertained, the rest of the problem is only a swift effort of memory, the days advancing in a regular sequence, accelerated by leap-years; but still, superior pace is a theory which does meet all the conditions." The existence of differences in the pace of mind being conceded, the question next arises whether speed can be cultivated. If it can, we have a way pointed out by which intelligent life may be rendered longer and fuller. Dr. Martineau is said to believe, what many other persons fancy, that the English middle class has in the last two generations gained so greatly that the gain is perceptible in mental quickness. The Brahmans of India are celebrated for their superiority in this faculty. Teachers admit that the children of the educated poor are easier to teach than children of the uneducated poor; that "they have not only more 'receptive minds,' which may mean only better memories, but that their minds move positively quicker." On the other hand, the English educated never seem as quick as the Irish uneducated.

The Destiny of Sea-coast Land.—Among the results of his examination of the provisions of the shore towns of Massachusetts for public places of resort, and the industries and resources of the people, Mr. J. B. Harrison says, in Garden and Forest, that he found "everywhere recent changes in the ownership of land and a movement of people of means from the cities and the interior of the country to the shore regions of the State. I found leagues and leagues together of the shore line all private holdings, without a rood of space in these long reaches to which the public has a right to go. . . . I found a great population inland hedged away from the beach, and all the conditions pointing to a time, not remote, when no man can walk by the ocean in Massachusetts without payment of a fee, as we formerly had to pay for glimpses of Niagara. I could see that the movement for open spaces for public resort has vital relations to civilization, and has been instituted in response to a pressing need." In view of the changes in industrial conditions that are likely to take place under these circumstances, Mr. Harrison finds one resource which has received comparatively little attention of late—the soil, which in most of the shore towns appears to be much better than the popular estimate of it. "It has greater capabilities than are yet recognized. This is especially true of the Cape Cod country. The soil there is better than that of southern New Jersey; and I have seen many Massachusetts men in Dakota, Montana, and Idaho, trying, in great privation, to make a living in regions more forlorn and hopeless than any part of the shore country of the Old Bay State. . . . I think these towns might yet support a great population by a highly developed agriculture and horticulture, and that owners of the land might wisely keep it and cultivate it."

Snow Effects in the Pamirs.—The region of the Pamirs, or the roof of the world, in central Asia, where the empires of Russia, India, and China corner upon one another, consists of a succession of long, broad, open valleys, running approximately parallel to each other in a general direction from northeast to southwest, and separated by low (for that region) ranges of mountains. The climate is very severe. The lowest point of the Pamirs is 10,300 feet above sea-level, and their usual average is from 13,000 to 14,000 feet. Hence the cold must be very intense. Captain Younghusband, while he had no experience of the winter weather, found temperatures at the end of October and beginning of November of 18° Fahr. below zero. Some interesting snow phenomena were witnessed by this explorer. He has looked at a mountain-peak, and then, a few moments later, seen it gradually disappear; and only by closer observation could he make out that it had been overshadowed by an imperceptible snow-storm. "The snow, indeed, in these mountains was often very fine, and almost like dust; and a very beautiful effect is, that it nearly always falls in perfect little hexagonal flakes, like little stars of lacework, each one quite distinct, and remaining intact until it reaches the ground; then, as it has fallen, the snow of course remains white on the surface, but, digging into it, appears of a beautiful delicate pale-blue color. Another effect of the snow is seen at the mountain-tops, when the peaks seem to be fading away, and vanishing off like clouds of whitened smoke. It is produced by the high wind blowing away the fine dust-like snow at the summits. Again, another almost similar phenomenon on the mountain-tops is that of long, level clouds, like streamers, flowing away from the peaks. The moisture-laden air from the plains of India has been condensed on the icy mountain summits, and the wind has blown the mist away in a long, thin streamer." Another effect of snow-particles glittering in the air in clear sunlight is also common among us on very cold winter days.

The "Down-below People."—The Havesu-Pai, otherwise known as the Koxoninos, or Cochnichnos, are a dying race of Indians, their numbers being estimated at less than two hundred souls, who were visited a few years ago by Mr. Benjamin Wittick. Dr. R. W. Shufeldt, seeking for information about them, has found that very little is known concerning them, but was able to obtain two photographs taken by Mr. Wittick, illustrating their general appearance and the style of their huts. They exist in one of the grandest cañons in Arizona, living along the banks of the stream that passes through it. Their name, which is given them by the Yumas, means the "down-below people," or a tribe or race that live down in the cañon. They call themselves the "Ah-Supai." The cañon in which they dwell is that of Cataract Creek, is forty-five hundred feet deep, and the stream tumbles by a series of cascades into the Grand Cañon of the Colorado, fifteen hundred feet deeper. The Indians raise, according to Captain John G. Bourke, fine peaches and good corn and melons, and weave fine and beautiful baskets. They are great hunters, and live by trading off buckskins and sometimes mountain-lion pelts to the Moquis, Navajos, and Apaches. Mr. Frank H. Cushing describes their home as in a green, moist plain of sandy soil, nearly two miles long by half a mile at its greatest width, of which he could catch only occasional glimpses through the rank growth of willows with which the trail was lined. "These glimpses, however, revealed numerous cultivated fields of corn, beans, sunflowers, melons, peaches, apricots, and certain plants used in dyeing and basket-making, and usually carefully protected by hedges of wattled willows or fences of cottonwood poles. Everywhere these fields were crossed and recrossed by a network of irrigating canals and trails. Here and there were little cabins, or shelters, flat-roofed, dirt-covered, and closed in on three sides by wattled flags, canes, and slender branches, while the front was protected by a hedge like those of the fields, only taller, placed a few feet before the house, and between which and the house burned smoky fires. The houses were always nestled down among the thick willows bordering the river, or perched on some convenient shelf, under the shadows of the western precipices." Little buildings of stone laid in mud plaster, somewhat like the cliff dwellings, were also seen in the horizontal cracks of the western cliffs, often high up. These Indians have medicine-men, use the sweat-house, possess many dogs, have considerable families, and are on good terms with the whites.

The Purposes and Arrangement of Museums.—The museums of the future in this country, says G. Brown Goode, "should be adapted to the needs of the mechanic, the factory operator, the day laborer, the salesman, and the clerk, as much as to those of the professional man and the man of leisure. It is proper that the laboratories be utilized to the fullest extent for the credit of the institution to which they belong. No museum can grow and be respected which does not each year give additional proofs of its claims to be considered a center of learning. On the other hand, the public have a right to ask that much shall be done directly in their interest. They will gladly allow the museum officer to use part of his time in study and experiment. They will take pride in the possession by the museum of tens of thousands of specimens, interesting only to the specialist, hidden away perpetually from public view, but necessary for purposes of scientific research. These are foundations of the intellectual superstructure which gives the institution its standing. Still, no pains must be spared in the presentation of the material in the exhibition halls. The specimens must be prepared in the most careful and artistic manner, and arranged attractively in well-designed cases and behind the clearest of glass. Each object must bear a label, giving its name and history so fully that all the probable questions of the visitor are answered in advance. Books of reference must be kept in convenient places. Colors of walls, cases, and labels must be restful and quiet, and comfortable seats should be everywhere accessible, for the task of the museum visitor is a weary one at best. In short, the public museum is, first of all, for the benefit of the public. When the officers are few in number, each one must of necessity devote a considerable portion of his time to the public halls. When the staff becomes larger, it is possible by specialization of work to arrange that certain men may devote their time uninterruptedly to laboratory work, while others are engaged in the increase of the collections and their installation."

The Technical School at St. Etienne, France.—At the technical school in St. Etienne, France, according to the United States consul in that city, three hundred students are taught weaving, dyeing, sculpture, iron-founding, cabinet-making, and other arts, free of charge. The apprenticeship course lasts four years, and after completing it a certificate of aptitude is given, under which the pupil may obtain a situation in the line of industrial labor he has chosen. In the first year the students pass through all the workshops, to be initiated into the proper handling of the different tools. After that, the boys are classed according to their tastes, desires, and aptitudes. They work at manual labor three hours daily during the second year, four hours in the third, and five hours in the first and seven in the last six months of the fourth and last year. Great attention is paid to the teaching of the theory of the different trades, the fitters being taught to trace and cut out cog-wheels, and the carpenters to design and execute a certain number of works, such as stairs of different kinds, shutters, balconies, etc., on a reduced scale. The weavers are also given special lessons in book-keeping, legislation, commercial geography, and one of the modern languages. Careful attention is paid to design.

Embroidering by Machinery.—The recent invention, at Arbon, of a new steam machine for making embroideries threatens, says Consul Byers, of St. Gall, to revolutionize some of the most important manufacturing interests of the Swiss Republic. Eastern Switzerland, with St. Gall as a center, has been for a hundred years the headquarters of the embroidery industry of the world. Embroidery by hand alone had been practiced when the present hand-machine was brought into use in 1827. Under the former system the technical skill and readiness of hand of the Appenzell women were marvelous, and the embroidery made by them became famous all over the world. At the present day possibly not five per cent of the embroideries are made exclusively by hand. The Schiffli steam machine, invented about fifteen years ago, produces a low class of goods of inferior quality. For the more recently invented Arbon machine its owners claim that it will at least triple the product of the hand-machine, that it can produce goods cheaper, and can turn them out of better quality than the old method, and do it without so much wear and tear to the muscles of men and women.

The Puma.—The puma (*Felis concolor* of Linnæus), known also as the panther, painter, cougar, American lion, and by several other names, is, according to Mrs. Frederick W. True, the only large, unspotted native American cat. It varies much in color, and is from five to seven feet long. The area over which it ranges extends from New England and British Columbia to the straits of Magellan. On the Atlantic coast the species has apparently not been found in New Hampshire, Rhode Island, New Jersey, or Delaware. No mention appears of its having been found in Michigan or Indiana. It was extirpated in Ohio before 1838, and probably more recently in Indiana and Illinois. With these exceptions, and Nevada, there are recorded instances, more or less numerous, of the occurrence of the puma, since the beginning of the century, in every State and Territory of the Union. Regarded as a species, the puma possesses in a remarkable degree the power of adapting itself to varied surroundings. It endures severe cold during the winter in the Adirondack Mountains and other parts of our northern frontier, and hunts its prey in the snow. It is equally at home in the hot swamps and canebrakes and along the river-courses in our Southern States. In South America it inhabits the treeless, grass-covered pampas, as well as the forests. In the Rocky Mountains it ascends to the great altitudes at which the mountain sheep are found; and it is also met with high up on other ranges. It selects for its abode such spots as afford some shelter, but is found in the thickets and copses rather than in the great forests. It seeks its prey chiefly at dawn and twilight and under cover of night, but sometimes also hunts by day. Deer are its principal quarry, but it also preys upon the smaller mammals and on wild turkeys. Of the larger domestic animals, such as the horse and cow, it attacks only the young, but it will carry away a full-grown sheep from the fold, and in South America often preys upon the llama. It does not ordinarily attack men, but is disposed to flee from them when surprised; but such attacks have been known. Like the cat, it scratches the bark of trees, purrs when satisfied, and has been heard to mew.

Influence of the Indian Trade.—As to the effect of the Indian trading post, Mr. Frederick J. Turner says, in a paper on The Character and Influence of the Indian Trade in Wisconsin, of the Johns Hopkins Historical and Political Science Series, that, giving him iron and guns and a market for furs, it tended to prolong the hunter stage; leaving the unarmed Indian at the mercy of those who had bought firearms, it caused a relocation of tribes and a demand for the trader by remote and unvisited Indians, made the savage dependent on the white man's supplies, and gave the Indians means of resistance to agricultural settlement. On the side of the white man, the Indian trade gave both French and English a footing in America, invited exploration, and fostered the advancement of settlements as long as they were in extension of trade. In Wisconsin the sites of the principal cities are the sites of the old trading posts, and those earliest fur-trading settlements furnished supplies to the farming, mining, and lumbering pioneers. Reports brought back by the individual trader guided the steps of the agricultural pioneer. The trader was the farmer's path-finder into some of the richest regions of the continent. In Wisconsin, at least, the traders' posts, located at the carrying-places around falls and rapids, pointed out the water-powers of the State. The trails became the early roads. "An old Indian trader relates that the path between Green Bay and Milwaukee was originally an Indian trail and very crooked, but the whites would straighten it by cutting across lots each winter with their jumpers, wearing bare streaks through the thin covering, to be followed in the summer by foot and horseback travel along the shortened path. The process was typical of a greater one. Along the lines that Nature had drawn, the Indians traded and warred; along their trails and in their birch canoes the trader passed, bringing a new and transforming life. These slender lines of Eastern influence stretched throughout all our vast and intricate water-system, even to the Gulf of Mexico, the Pacific, and the Arctic Seas, and these lines were in turn followed by agricultural and by manufacturing civilization."

French Silk-weaving Centers.—According to the United States consular clerk at Lyons, the geographical position of silk-weaving in France has undergone considerable changes since the introduction of the industry. Cities in which silk-weaving was formerly of great importance, have turned their attention toward other industries, while new centers have sprung up and attained more or less prosperity. Tours was the first great silk-weaving center of France, but its industry in this line has been declining for the last sixty years. Nîmes was likewise one of the early centers, and reached great prosperity in the eighteenth century; but it has now less than one sixth as many looms as it had then. About twenty-five thousand looms are employed in Paris and the adjoining districts in weaving silk and silk-mixed goods, galloons, fringes, cords, and other varieties of *passementerie* and trimmings. Nets, tulles, and laces constitute the specialties of Calais. Whenever the demand for silk nets is low, the manufacturers substitute cotton or wool on their looms. During the latter half of the present century Roubaix has become the center of an extensive industry, manufacturing silk and wool and silk and cotton-mixed goods. These articles, though often wanting in originality, find ready sale on account of their low price. At Saint-Chamond, silk-weaving has been established in a modest way ever since the thirteenth century; and by confining their attention to braids and similar articles, the manufacturers have advanced their specialties to a degree of excellence that has established for them a world-wide reputation. At Saint-Etienne the weaving of ribbons is carried on, with great variations in the value of the yearly manufacture. Lyons is considered the most important silk center of France, and of Europe as well. Its total production averages about $80,000,000 a year. The quantity of goods produced is now greater than ever before, and constitutes two thirds of the production of France, and one quarter of the total production of the world.

Swiss Watch-making.—The Swiss watch industry is chiefly situated in the west of Switzerland, where the French language is spoken, and particularly in Geneva, Vaud, the canton of Neutchâtel, and the Bernese Jura. An ingenious labor organization has sprung up there, which combines at once the advantages of principal and minor industry. Composed of small workshops, grouped in a given region, it is under the control of a manufacturer who gives orders to the workman, and supplies him with the necessary materials, and, when the watch is finished, effects a sale. Under this system the master has not the general expenses of a factory, and the diminution in production and holidays affect him but little. In his turn, the operative working at home has a particular part of the watch to construct. He is both journeyman and foreman, who combines his dwelling with his shop. Paid by the piece, he works at his leisure from early in the morning till late at night. Such a system, which allows the wife to assist in the labors of the husband, and the children to be initiated by an easy apprenticeship into the manufacture of a special part of the watch, must suit the mountaineers. They preserve their intelligence, realize often large profits, and by the intelligent practice of industrial art improve their social status. Little by little the heads of business houses have drawn into their locality a large number of families from the rural districts, and in the mountains, at one thousand metres altitude, and on the plains where only the abundant pasturage affords a means of livelihood for the native, towns have risen rapidly—for instance, Chaux de Fonds, Locle, and Saint-Imier. Thus, the system of collective industry, with work at the domestic hearth, has formed several generations of watch-makers. But, for thirty years, competition, and particularly American competition, has necessitated the erection of works with mechanical appliances.

The Sources of Gutta Percha.—Of the various kinds of gutta-percha, only those produced by trees of the old genus *Isonandra*, now sunk in *Dichopsis*, are available for use as insulators of cables. Their natural habitat is exclusively in the Malayan region. The destruction of this zone of forests proceeds rapidly. The natives cut every available tree, and repeat the process as fast as the plants spring up again. The scanty plantations started in the East Indies are, moreover, not formed of the best species, but of those which yield an inferior product. The best species has, in fact, become excessively rare, but is still in existence. Its adult representatives were yet propagating themselves in 1887 at the Chasserian estate in the ravines of the ancient forest of Boukett Tinah, in the center of Singapore. When M. Sérullas, of Paris, found the spot in 1887, gutta-collecting had ceased for thirty years.

The Kanjutis.—The Kanjutis, of Hunza, the robber tribe of the Pamir table-land, inhabit the deeply cut valley which runs from the apex of central Asia, where the Hindu-Kush and Himalaya systems meet, and the water-shed between eastern and western Asia joins that between northern and southern Asia. Captain Younghusband found them to be small, well-built, hardy, determined, though not fierce-looking men, wearing long black curls, which gave them a very wild appearance. Perhaps the most remarkable feature about them is their capacity for endurance. "They issue from their strongholds on their raiding expeditions, and cover often two hundred miles of mountainous and uninhabited country, entirely on foot, and carry their own supplies for the whole distance on their backs; and I have known cases of men carrying news of my movements to their chief in an incredibly short time. Dressed in long cloaks of thick, homemade woolen material, they sleep out in the open in the most intense cold, and yet live upon almost nothing. They are also very avaricious, although they know and care little for money; but they covet goods greedily."

A Stronghold of Birds.—The Bird Rocks, or Three Islands of Birds, near Newfoundland, were so resorted to by gannets in Audubon's time that their tops seemed covered with snow. The birds were then much used for bait, and Audubon's captain told him that his boat's crew had once killed six hundred and forty of them in an hour, with no better weapons than sticks. Up to 1860 they covered the tops of the rocks and many of the ledges on the sides. The erection of a lighthouse on the Great Rock, in 1870, was followed by a rapid decrease in numbers. In 1881 Mr. Brewster found the birds on the Great Rock confined to the ledges along the sides, while the Little Rock was still densely populated. In 1887 not a gannet was raised on the Little Rock, although a few were breeding on the pillar of rock adjacent to it. The murres, razor-bills, and puffins, Mr. Frederick A. Lucas believes, have probably suffered somewhat less than their more conspicuous comrades, although even among them the decrease must have been very great. Still, their smaller size, and consequent ability to breed in crevices of the rocks and on ledges too narrow to accommodate a bulky gannet, has been of great service to them; while the razor-bill also seems to be learning by experience the desirability of putting an egg out of sight whenever practicable. The puffins find safety in their burrowing habits, and breed extensively in the decomposed sandstone at the northeastern portion of the Great Rock, as well as under the overhanging inaccessible ledges of the northern side of the Little Rock. The little rocky pillar already mentioned is well occupied by birds of various species, and, owing to the difficulty of scaling the rock, the little colony is fairly secure. But, from its size, the precipitous nature of the sides, and the fact that only one landing lies contiguous to the breeding birds, the Great Bird Rock must ever remain the stronghold of this interesting colony of sea-fowl. There is no regular division of the birds into large colonies according to species, but the separation is rather by size, gannets occupying the highest and broadest ledges, and murres and razor-bills taking what is left.

A Buddha, and its Meaning.—A bronze Buddha in the United States National Museum, as described by Charles De Kay, is thirty-eight inches and three quarters, or including the halo, seventy inches high, has a bronze halo, and differs from the famous seated Buddha at Kamakusa in size and in the position of the forefingers. These do not touch each other along the two upper joints, but lie one within the other. A slight trait of this kind is of the greatest importance to a Buddhist. It marks the difference between figures of the greatest of all Buddhas at the moments of his ecstasy or absorption into the Nirvana, or it distinguishes the Buddha from foreign or local saints who have presumably reached Buddhahood by meritorious pondering. The figure has the famous knob on the forehead, about which many legends revolve; also the short round curls over the head, supposed to be the snails which guarded Buddha from sunstroke, and it carries the mark on the top of the head. It has the large ears, with their lobes pierced and distended, but no ear-rings. The figure represents Buddha, after having taught his doctrine, merging himself into Nirvana. To an adept, the position of the thumbs and forefingers expresses a world of hidden meanings. The figure is luckily provided with a copious inscription which is couched in phrases anything but easy of translation. Its name is "the Buddha of the Five Wisdoms," and its motto, "All the world can share the blessings of Buddhism."

Biological Physiology.—The Director of the Marine Biological Laboratory (Wood's Holl, Mass.) for 1891 calls attention to the needs of physiology as one of the most important branches of biological science which, for want of room, has thus far been neglected. It is not animal or human physiology, as commonly understood, that the director has more especially in mind, but what he calls biological physiology, or the province of the biological economy of organisms. "It is in this almost new province that we meet the great problems of geographical and geological distribution, and those of the interrelations of species in both the animal and vegetable kingdoms. It is here that we study life-histories, habits, food; the influences of the physical environment, and the reciprocal relations, which are ever varying according to the issues of the universal struggle for existence. It is in this direction that experimental physiology finds one of the most inviting fields in the whole range of biology." As instances of what varied and interesting problems here await the experimenter, are mentioned the experiments of Pflüger and others to determine the influence of gravitation on the development of the egg; Boveri's experiments to determine where the formative power resides, and whether it is shared equally by both sexes; Fol's studies on fertilization; Auerbach's determination of the sexual distinction between the paternal and the maternal elements of the nucleus; Weismann's studies on the laws and causes of variation; the effects of chemical agencies on germ-cells as tested by Oscar and Richard Hertwig; the experiments of Beudant, Plateau, and Schmankewitsch in transferring animals from fresh to salt water, and *vice versa;* Semper's observations on the effect of the volume of water on the size of the creatures living in it; and others.

A Meteorological Poet.—A curious paper has been published by Naval Surgeon Grémaud, of Brest, France, on the tempest described in the first book of Virgil's Æneid. He answers some of the criticisms that have been made of it, and shows that the critics were not meteorologists. Having carefully compared the latest accounts of cyclones with Virgil's description, he has found the descriptions of the dangerous semicircle, the tractable semicircle, the plunging winds, and the columns of water rising like a wall and falling upon the ships to demolish them, correct; and establishes a complete analogy between them and the determinations of science. Hence, Virgil was not only a poet, but a good meteorologist as well—one of the scientific men of his time. M. Vice-Admiral Vignes, President of the Geographical Society of Paris, on reading the paper, remarked that he was surprised to find in Virgil the exact laws of cyclones, which sailors did not learn till a comparatively modern time.

British Fisheries.—The North Sea fisheries of Great Britain were reported at the meeting of the British Association to be declining. It was proposed to draw up a history of the North Sea trawling grounds, comparing their present condition with their condition some twenty or thirty years ago, when comparatively few boats were at work; to continue, verify, and extend observations as to the average size at which prime fish became sexually mature; and to collect statistics as to the size of all fish captured in the vicinity of the Dogger Bank and to the eastward, so that the number of immature fish annually captured may be estimated; also, to make experiments with beam trawl nets of various meshes with a view to determine the relation, if any, between the size of mesh and the size of fish taken.

The Kingfisher.—The habits of the kingfisher (*Halcyon vagans*) are the subject of a paper by Mr. J. W. Hall, of the Auckland (N. Z.) Institute. His observations, while not decisive, favor the opinion that kingfishers capture live birds. They are also sometimes captured by hawks; but the hawk does not always come off best. One day the author saw a hawk sailing round the bend of a hill followed by a kingfisher. Then at once arose a great outcry, and the hawk came again in sight, bearing the kingfisher in its talons. But, nothing daunted, the kingfisher with its pickaxe of a bill pegged away at the breast and abdomen of its captor to such good effect that the hawk was glad to liberate its prey, whereupon the kingfisher flew away, apparently but little the worse for the encounter, and carrying with it the full sympathy of the onlookers.

NOTES.

The Japanese observe very exact proportions between leaves and flowers in the arrangement of irises. With three leaves they use one flower, with seven leaves two flowers, with eleven leaves five flowers, with thirteen leaves only three flowers, and with fifteen leaves only two flowers again. When we examine pictures that show the results of the application of these rules, says Garden and Forest, we are convinced that they have been dictated by a very true feeling for artistic effects of the most delicate sort.

According to the analyses of Dr. C. F. Millspaugh, of the West Virginia Experiment Station, weeds vary largely in the percentages of nitrogen, phosphoric acid, and potash which they contain. One of the evening primroses has only one per cent of nitrogen, while the poke-weed has three per cent of that substance, and a dry ton of the weed will contain twenty-two dollars' worth of it. By composting weeds with plaster, a valuable manure may be obtained.

According to the story of George Hunt, keeper of the lighthouse at Tillamook Rock, on the Pacific coast, in the storm of December 7, 1891, the waves swept clear over the house, washing away the boats, and tearing loose and carrying off the landing platform and tramway which were bolted to the rock. On the 29th the waves were still higher, and streams of water poured into the lantern through the ventilators in the balloon top of the dome, one hundred and fifty-seven feet above the sea-level.

Dr. Alanus, a translation of whose letter relating his experiences is published in the Medical and Surgical Reporter, says that after having lived for a long time as a vegetarian without feeling any better or worse than he had felt with a mixed diet, he discovered one day that his arteries were showing signs of atheromatous degeneration. Consulting a work by Dr. E. Morin, of Paris, he found that affection pointed out as one of the results of living on an exclusively vegetable diet. He now no longer considers purely vegetable food as the normal diet of man, but only as a curative method of great service in various morbid states.

According to an article in the Overland Monthly, many women in California gain a livelihood by raising flower bulbs and seeds for market, and many others send to San Francisco every day hampers of wild flowers and ferns which have been picked from the neighboring cañons. Mrs. Theodosia Shepherd, of Ventura, stands foremost among these successful floriculturists, although only eight years have passed since, without means and broken down in health, she grew her first seeds for market in the old mission town of San Buena Ventura. She now fills orders from prominent Eastern florists, with occasional calls from Europe, Australia, and the Sandwich Islands.

An attempt has been made by Herr Pfeiffer to prove and measure, by the change in electric conductivity, the solvent action of water on glass. He found that a cubic centimetre of water dissolved at 20° C. in one hour from one to two millionths of a milligramme from a square centimetre surface of glass; that with temperature rising arithmetically, the growth of solubility is considerably more rapid than that of a geometrical series; that the increase of conductivity of the water for a given kind of glass under like conditions is a characteristic constant; and that later, when a certain quantity of alkali is dissolved, further action involves a dissolving also of silicic acid, and the salts then formed may cause a decrease of conducting power.

A VEIN of asbestos has been found near Broken Hill, New South Wales, in which there are fibers thirteen inches long, of silky and flexible texture, but less tough than Italian asbestos. It is reddish in color.

THE sixth annual meeting of the Iowa Academy of Sciences was held at Des Moines, December 29th and 30th. The programme of discussions was full, and besides technical subjects of biology, zoölogy, petrology, etc., included several topics of domestic and other economical importance, such as the determination of the active principles of bread-making, the bacteria of milk, the effect of feeding on the composition of milk, sugar beets, the coal-bearing strata, brick and other clays, and aluminum in Iowa; the artesian well question, and the report of the committee on State fauna. The President of the Academy, Prof. C. C. Nutting, made an address on Systematic Zoölogy in Colleges, and Mr. J. E. Todd gave some Further Notes on the Great Central Plain of the Mississippi.

THE statement that the adoption of electric lighting in the English Savings-Bank Department has been followed by a considerable reduction in the amount of sick-leave points to what will probably be one of the chief advantages of this mode of lighting rooms. An electric lamp does not draw on the oxygen of the room, and does not give off irrespirable gases as do gas and oil lights.

ACCORDING to the Minneapolis Tribune, as cited in Garden and Forest, the leading opponents of the proposed forest reservation in northern Minnesota have become supporters of the measure. The Duluth Chamber of Commerce sent its secretary, Mr. Thompson, to the meeting of the State Forestry Association, to protest against the movement, but when he learned that instead of withholding the timber from use it was proposed to secure a constant lumber-supply, and that the forests when protected from fire and larceny would be more productive than they are under the present lack of supervision, Mr. Thompson himself joined the Association and was made a member of the Executive Committee, which is laboring to induce the President to make the proclamation withdrawing the forest lands from sale and entry.

A COLLECTION of letters and unedited memoirs by the Swedish chemist, Scheele, is in course of publication, under the direction of Baron Nordenskiöld. The question of preparing an English-American edition of the work is under consideration.

IN the Cambridge Antiquarian Society, November 11, 1891, Prof. Hughes described the results of his examination of some deserted Indian villages in Arizona, one of which consisted of caves excavated in the top of a small hill of lava; and another of dwellings built under the shelter of overhanging ledges in the cliffs of the Walnut Cañon, much resembling the cliff dwellings of mediæval times along the rivers of Dordogne.

STATUES of Boussingault, by M. Dalou, and Chevreul, by M. Fagel, are to be erected in Paris, in connection with the Conservatoire des Arts et Métiers. The Chevreul statue is a repetition of one executed by M. Fagel in 1889.

MANGANINE is the name of a new alloy, consisting of copper, nickel, and manganese, which has been brought into the market by a German firm, as a material of great resisting power; it having a specific resistance higher than that of nickeline, which has hitherto passed as the best resisting metal. It is said to be affected in only minute degree by high temperatures, and is therefore adapted for the manufacture of measuring instruments and measuring apparatus in general, which are required to vary in resistance as little as possible under different degrees of heat. While the resistance of other metals is increased by the raising of their temperature, that of manganine is diminished.

THERE is an art in dusting which does not receive the attention it demands. According to the various analyses of different observers, the components of ordinary dust exhibit special characters in almost endless variety. Mineral matters, animal and vegetable *débris*, morbid germs, and whatever is small and light enough to remain for any time suspended in the air, falls into the category; and among these things are many substances that in the air do mischief. The spread of cholera and exanthematous diseases has, doubtless with truth, been attributed to its influence. Methods of dusting, therefore, which merely remove the dust to another place or fill the air with it, are not sufficient and are not harmless. It should be wiped rather than brushed away, and carried away off, or destroyed. Then let the sunlight in to kill the infection that may remain.

AN examination of tinned peas, greened, by Drs. M. Charteris and William Snodgrass, of Glasgow, showed, by deposits on the crucible and on the blade of a steel knife inserted into the gastric solution, the presence of copper. The copper and its albuminate were digested in solutions similar to those of the pancreatic and gastric juices, and in the stomach of the living animal. Administered to a rabbit and a pig, the salts of copper produced toxic symptoms.

A novel rice-pounding machine used in the northern Shan states (Indo-China) is described by Lord Lamington as including bamboo pipes through which water is led into a hollow cut into one end of a pestle such as is usually worked by foot. The other or mallet end rises with the weight of the water till the water is automatically discharged, and then the pestle falls back and does its work of pounding the unhusked paddy.

The *Acarus sacchari*, or sugar-mite, is very frequently found in raw sugar, but not in refined. In an inferior sample of raw sugar, Prof. Cameron found five hundred of the organisms in ten grains. They may be avoided by eating only refined sugar, but it is doubtful if they would do any harm if they were eaten. The disease known as "grocer's itch," however, is probably due to the presence of this mite, which works its way under the skin and produces symptoms identical with those produced by the common *Acarus scabiei*, and the remedies are the same for both. The parasites multiply very rapidly, and Gerlach found that a single female would produce fifteen hundred thousand progeny in three months. The most common agents for destroying them are mercuric chloride and sulphur.

Discussing the value of the tree as a schoolmaster, Garden and Forest presents as the first of its lessons that "it teaches man to reserve judgment by showing that the insignificance of a germ is no criterion of the magnitude of its product, that slowness of development is not an index of the scope of growth, and proves to him that the most far-reaching results can be attained by very simple means. A barrel of acorns may be the nucleus of a forest that shall cherish streams to fertilize a desert; a handful of cedar cones may avert an avalanche, while a bushel of pine seed may prevent the depopulation of a great section of country by mountain torrents."

It should be mentioned pertinently to President Jordan's article on Agassiz at Penikese, that the buildings of the Anderson School on that island were totally destroyed by fire in August, 1891. The fire caught—Mr. George O'Malley, of New Bedford, informs President Jordan—under one corner of the building, and in a very short time nothing was left.

The Laboratory for Investigators of the Marine Biological Laboratory at Wood's Holl, Mass., will be open from June 1st to August 1st. The laboratory for teachers and students will be opened July 6th for regular courses of seven weeks in zoölogy, botany, and microscopical technique. The number of students will be limited to fifty, and preference will be given to teachers and others already qualified. Students may begin their individual work as early as June 15th without extra charge. A spacious new wing of the laboratory building will be ready for use on July 1st.

A summer course in botany is held annually in the lecture-room of the College of Pharmacy, 209 and 211 East 23d Street, New York, to consist of ten lectures, beginning this year April 28th, and closing with the excursion of July 5th. The extensive appliances for instruction of the institution are used; fresh material is collected weekly; and competent lecturers are provided by a committee of the Torrey Botanical Club. In addition to the lectures, the course includes ten excursions. The lectures will be given on Thursdays, at four o'clock in the afternoon, and the excursions will be made on Tuesdays and Saturdays, each member choosing the series of excursions which he will attend.

The fourth meeting of the Australasian Association for the Advancement of Science was held at Hobart, Tasmania, January 7th to 14th, under the presidency of Sir Robert Hamilton, and was in every way successful and creditable. The president, in his inaugural address, gave a sketch of the history of the Royal Society of Tasmania, and suggested reasons why all intelligent persons in Australia should do their utmost "to hasten the advent of the time, which is undoubtedly approaching, when science will form a much more integral part of the life of the people than it does at paesent." The next meeting will be held at Adelaide, and Prof. Tate will be its president.

OBITUARY NOTE.

Dr. Charles Meymott Tidy, an eminent English chemist and analyist, died March 15th. He had been joint lecturer on chemistry and Professor of Chemistry and Medical Jurisprudence and Public Health at the London Hospital, and was at the time of his death Official Analyist to the Home Office and Medical Officer of Health for Islington. He also held the office of Reader of Medical Jurisprudence at the Inns of Court. Among his publications were a course of Cantor Lectures on the Practical Applications of Optics to the Arts and Manufactures and to Medicine; a paper on the Treatment of Sewage; a work on Legal Medicine; a paper on Ammonia in the Urine in Health and Disease; and a Hand-book of Modern Chemistry, the second edition of which appeared in 1887.

LUIGI GALVANI.

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ANTHROPOLOGICAL WORK IN AMERICA.

By Prof. FREDERICK STARR.

THE object of this article is not to present a history of anthropology in America, but to sketch briefly some of the work at present done, so as to show the aims and methods of our workers in the science.

That anthropology is yearly attracting greater attention among us is shown by the way in which institutions of learning are recognizing its importance. Not many years ago a scientific journal made the statement that but one institution of learning in the United States, the University of Rochester, had the science upon its curriculum. The way in which it was introduced there is somewhat interesting. At that time the scientific work offered to students at Rochester was admittedly insufficient in quantity, but the way seemed hardly clear to the employment of any additional teaching force to do extra work. At this stage of affairs Prof. Joseph Gilmore, in charge of the Department of Rhetoric and English Literature, offered, in some degree at least, to meet the need, to announce an optional course in anthropology. The work was very elementary, extending over but a single term, and covering the field considered in De Quatrefages's little volume, The Natural History of Man. From the beginning the course was a favorite one, and many students elected it. The effect was good and the example has been followed. Since that time instruction in anthropology has entered into the work of a considerable number of American colleges and universities. It is suggestive to inquire how and why it has been introduced. At Yale, Prof. Sumner has for several years given such courses, because he felt that students unacquainted with the science could not profitably undertake his work in political science and economics. At Union College, Prof. Hoffman has found it necessary to give lectures on anthropology, as preliminary to the best work in psychology. At the University of Mississippi we believe it has been introduced as fundamental to historical study. In one way or another the subject has been crowding itself into the curricula, until now, in addition to the institutions already mentioned, Brown, Harvard, Clark, Vermont, and the University of Pennsylvania offer facilities for such study. At the new University of Chicago anthropology is to be recognized, and several courses, covering a wide field, will probably be offered. The work at two or three of the universities deserves special notice. At Yale, Prof. W. G. Sumner gives two courses of instruction in alternate years—one for undergraduates, the other for graduate students. The elementary course is based upon Tylor's Anthropology and Joly's Man before Metals, both of which are carefully read by the students, and form the basis of class-work. Lectures, discussions, and preparation of original papers upon selected topics make a suggestive and excellent course. Supplementary reading of important French and German writers is arranged for such students as desire to do the best work. In the second course similar methods are pursued, and the required reading consists of Topinard's Anthropology and Letourneau's Sociology. These two courses are deservedly popular with the students. The instruction work in anthropology at Harvard is an outgrowth of the Peabody Museum of American Ethnology. Of the museum itself we shall speak later. The work of Harvard University is divided into twelve departments, of which the most recently established is the Department of American Archæology and Ethnology. This department is equal in rank to any in the university, being on the same footing as the Department of Ancient Languages, or the Department of Mathematics. Graduate work leading to a Ph. D. degree is offered. We quote the following announcement from the latest catalogue:

Prof. W. G. Sumner.

"A course of special training in archæology and ethnology, requiring three years for its completion, will be given by Prof. Putnam. It will be carried on by work in the laboratory and museum, lectures, field-work, and exploration, and in the third year by some special research. The ability to use French and Spanish will be necessary. For this course a knowledge of elementary chemistry, geology, botany, zoölogy, drawing, and surveying is required, and courses in ancient history, ancient arts, and classical archæology are recommended as useful." Students are now pursuing such study at Harvard under Prof. Putnam's direction. Since the establishment of this department a fellowship at Harvard University has been founded by Mrs. Mary C. Thaw, of Pittsburgh. Founded largely from personal admiration of Miss Alice C. Fletcher, and appreciation of her work, the fellowship is to be held by this lady during her life. In the event of Miss Fletcher's death, "the income from the fund of thirty thousand dollars is to be paid as a salary to such person as shall be appointed by the trustees of the museum to carry on the same line of work and research relating to the Indian race of America, or other ethnological and archæological investigations." At the University of Pennsylvania a special chair of American Archæology and Linguistics is held by Dr. D. G. Brinton, than whom no man in America is better qualified to offer courses in Indian languages. The broadest anthropological work at present offered in an American institution is that conducted by Dr. Franz Boas at Clark University, Worcester, Mass. Dr. Boas received his training in anthropological study in Germany. Although partial to work in the direction of comparative mythology and linguistics, he is thoroughly trained in the methods of ethnography and physical anthropology. A great traveler and an excellent field-student, he has done admirable work among the Eskimos and the tribes of the northwest coast of America. For several years he has directed an exploration among these people, supported by a fund

Prof. F. W. Putnam.

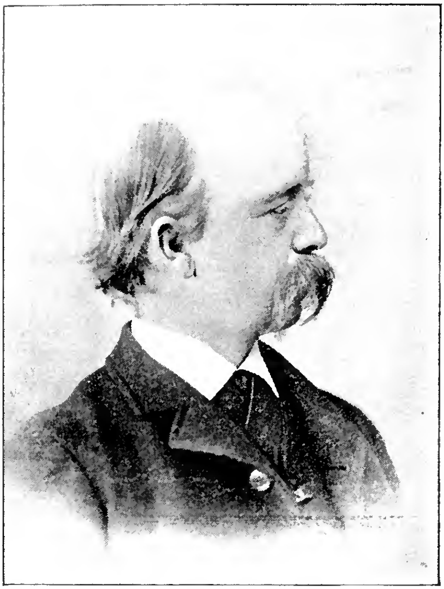
supplied by the British Association for the Advancement of Science, and his annual reports, published by that body, have been veritable storehouses of new and valuable information. Dr. Boas has lately prepared an important work upon the Mythology of North America, which will soon appear from the press. Dr. Boas is in charge of the Physical Anthropology Section of the Department of Ethnology and Archæology of the World's Columbian Exposition of Chicago. In connection with this work he plans to gather such a mass of anthropometric data concerning the red man as has never before been brought together. Within the next few months he hopes to have fully twenty thousand Indians of different tribes carefully measured. Important facts may be discovered from a careful study of the material thus secured. Dr. Boas at present lectures to a class of students upon statistics in anthropology and other sciences; how to secure, tabulate, and use them. Special graduate students are put at work in his laboratory, which is fairly equipped, upon some line of original research and study, the results of which may be published as contributions to science.

Albert S. Gatschet.

Museums in ethnography and anthropology are not yet numerous in America. Collections of considerable size and worthy of special notice exist at Cambridge, Salem, New York, Philadelphia, Washington, and Davenport. Of very great importance is the Peabody Museum of American Ethnology at Cambridge, connected with Harvard University, and under direction of Prof. Frederick W. Putnam. At first a zoölogist, especially interested in fishes, Prof. Putnam has long since laid aside everything except archaeology. The present work and importance of the museum are mainly due to him. Nine large rooms are filled with valuable collections, a great part of which have been gathered under his personal supervision. No man has done so much to bring about the careful and systematic method of excavation of mounds now followed as he. To refer to all the objects of special interest in this museum would take us far beyond our limits. Among the collections are magnificent series from the mounds of Ohio and the stone graves of Tennessee; complete altars of baked clay from Ohio "altar mounds"; Kentucky cavern finds; interesting series from the caverns of southern California, comprising perishable objects seldom preserved, such as a feather head-dress, basketry, wooden objects, and a wonderful lot of bone whistles found in a single basket; Flint's interesting gatherings from Nicaragua; collections from the old cities of Yucatan; the Agassiz collection from ancient Peruvian graves; the rich yield from the Madisonville cemetery; Wyman's collection from the fresh-water shell-heaps of the St. John's River, Fla.; and the famous Abbott collection from New Jersey, the basis of Dr. Abbott's paper, The Stone Age in New Jersey. Two other series deserve especial mention—the one of specimens from Honduras, some of the pottery in which is exceedingly interesting as showing a field for exploration scarcely known to our archæologists. Prof. Putnam has made arrangements with the Government of Honduras whereby the museum has the exclusive right of archæological exploration in that country for a term of ten years. Mr. Saville, the museum assistant, is now in that field. Very important is the great collection of American "palæoliths." Here are Dr. Abbott's argillite implements from the Trenton gravels, and the skulls from the same locality; Miss Babbitt's quartzite flakes and rude implements from the Minnesota drift deposits; and the Ohio, Indiana, and Delaware specimens from post-glacial or glacial deposits. Nowhere else is there any such an exhibit of these rude, early types, which have caused so much bitter discussion. We have spoken only of American collections, but there are also in this museum series illustrative of European archæology, fine specimens from the South Seas, and a Semitic museum, which deserve more than a passing reference. The museum has published annual reports for twenty-four years; some of them have

Dr. D. G. Brinton.

contained papers of much value. At present octavo monographs by such writers as Mrs. Zelia Nuttall and Mr. A. S. Gatschet are also published by the museum. One important and original accomplishment of the museum remains to be mentioned. In Adams County, Ohio, on a high bluff at some distance from the nearest railroad town, is the *Great Serpent Mound,* in some respects the most remarkable monument of antiquity in America. It was in danger of destruction, when Prof. Putnam made an appeal for funds for its purchase and preservation. Ladies of Boston responded to the appeal, the money needed was raised, and paid over to the museum, which made the purchase. The place has been pleasantly laid out as *Serpent Mound Park*, and the old monument itself has been carefully surveyed, restored, and put into a condition to withstand the destroying action of time and the elements. Prof. Putnam is Director of the Department of Ethnology of the Columbian Exposition, and in connection with its work has kept parties in the field excavating mounds and gathering material. His plan of display is a vast one, and a most instructive and interesting object lesson in American anthropology (ethnography, physical anthropology, archæology) is sure to be prepared.



Dr. C. C. Abbott.

New York is not so much a center of anthropological work as it should be. At the American Museum of Natural History there is much good material. Here one may see what is left in America of the Squier and Davis collection from the Ohio mounds, containing many specimens figured in the Ancient Monuments of the Mississippi Valley; the Squier collection from Peru, comprising a wonderfully fine lot of greenstone carvings; the collection of Colonel C. C. Jones, made chiefly in Georgia, numbering five thousand specimens, and the basis of his book, The Antiquities of the Southern Indians; a remarkable collection in European archæology, including series from the river gravels and caves of France, from the lake dwellings of Switzerland, and from the famous localities of Denmark; the Emmons collection from

Alaska, which is perhaps the best collection from the Tlingits; the Sturgis collection from the South Seas, recently purchased by the museum, and far larger than any other in America, and surpassed by few in Europe. Besides these collections belonging to the museum, and on display, there are in the building two remarkable and extensive series belonging to private collectors—men of wealth—Mr. James Terry and Mr. Andrew E. Douglass. The Terry collection is mainly the personal gathering of the owner, and is particularly rich in Pacific coast specimens. The Douglass collection is made up of exceedingly choice stone implements from every part of the United States, and it is unsurpassed in the number of rare and beautiful objects—banner-stones, bird and bar amulets, hematites, and grooved axes. These two collections will no doubt ultimately become the property of the museum. Notwithstanding its treasures in material collections, the museum has never published one line of contribution to anthropological science, nor has it undertaken, apart from a few lectures to its membership, any educational work in the subject.

Prof. Edward S. Morse.

In Philadelphia a vast amount of work has been done by a few individual workers, with no pecuniary return, and with but very little financial backing. What is there has been brought about by truly heroic work from love of the cause. The work is mainly done at the Philadelphia Academy of Science or at the University of Pennsylvania. At the academy is the Morton collection of crania, gathered by our earliest great anthropologist, and at that time one of the largest in the world; here, too, are the collections in archæology gathered by Poinsett, Vaux, and Haldeman. For several seasons, including the present one, Dr. D. G. Brinton has presented at the academy courses of lectures upon some ethnological subject. The most active work in Philadelphia at present, however, is at the university. In reference to it, Mr. Culin, who is one of its heartiest supporters, writes us:

"The chief center is the new Department of Archæology and

Palæontology of the University of Pennsylvania, which is maintained by an independent organization—the University Archæological Association. This department covers a broad field. It has had an expedition for two years in Babylonia; it contributes annually to the Egyptian Exploration Fund; and has carried on explorations in various parts of the United States. In two years it has established a museum in four sections—American, Babylonian, Egyptian, and Oriental—with remarkably full collections in each. It has just opened a loan exhibition of objects used in worship, intended as the first of a series of such special exhibitions of an educational character in which the resources of the museum and of private collections will be made accessible and displayed."

Major J. W. Powell.

An unusual number of active societies exist in Philadelphia, which more or less directly assist anthropological science. Such are the American Philosophical Society, Numismatic and Antiquarian Society, and the Oriental Club. In all of these, so far as anthropological work is concerned, Dr. Daniel G. Brinton is a moving spirit. Dr. Brinton scarcely needs an introduction to American readers; no one has done more to make anthropology known to the people and to raise up other workers. His writings upon American religions are delightful reading. For several years he has edited a most important work, the Library of American Aboriginal Literature; of this some eight volumes have appeared. Each volume is devoted to some one literary production of the American race. The original text is printed in full; and a translation, critical notes, and a vocabulary make the subject available to the student. Dr. Brinton has lately issued two little volumes—Races and Peoples and The American Race—of popular but scholarly character. The other workers in Philadelphia who are best known are the curators of the departments of the University Museum, Dr. C. C. Abbott, Prof. Morris Jastrow, Jr., Mrs. Cornelius Stevenson, and Mr. Stewart Culin. Dr. Jastrow is one of the best Semitic scholars in America. Mrs. Stevenson is perhaps our only lady Egyptologist. She may justly be compared in that field to Miss Edwards, of England. Her lectures on Egyptian subjects have made a sensation.

To the work of Dr. C. C. Abbott we briefly referred in connection with the Peabody Museum at Cambridge. Dr. Abbott lived for many years at Trenton, gathering a great collection of archæological specimens from the State of New Jersey. The series, now at Cambridge, numbered many thousands of specimens, and was the basis for The Stone Age in New Jersey and for the later book Primitive Industry. In 1875 Dr. Abbott found the first argillite palæolithic implements in the Trenton gravel. This gravel is said by geologists to date back to the close of the Glacial Period, and any evidence of human workmanship in undisturbed gravels of that kind carries the existence of man in the Eastern United States back to a considerable antiquity. A lively warfare has been waged against these "finds." It has been questioned whether the objects *were* of human workmanship, and whether they were really of the same age as the gravels. But similar implements have been found in similar deposits in other States within the glaciated area, and each new discovery tends to establish those which preceded it. Since his connection with the University Museum, Dr. Abbott has continued field-work in the Delaware Valley, and has lately made many interesting discoveries, such as workshops where argillite implements (non-palæolithic, but ancient) were made and quarries where the Indians gathered their materials for arrow-heads and spear-heads. Dr. Abbott aims to exhaust the archæology of the Delaware Valley before he ends his work. Such thorough study of limited areas is what we most need in American archæology. After such work has been done for each section of the United States, then, and then only, can our students reach sure conclusions.

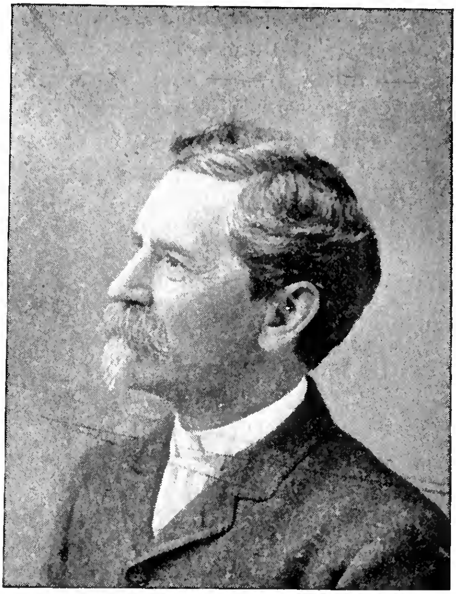
Garrick Mallery.

The loan exhibition of religious objects above mentioned is mainly due to the energy and efforts of Mr. Stewart Culin, who finds his most interesting work in the neglected fields of popular superstitions and games, and who is an earnest student of comparative religion. The exhibition was formally opened on March 16th, when crowds of visitors were present. The collection is the first of its kind publicly shown in America. It is on the general plan of the Musée Guimet in Paris, and, although not to be compared with that in size, it presents some valuable features that are lacking there. Some eight hundred objects illustrated Brahmanism, Buddhism, Taoism, Mohammedanism, the fetich-worship of South Africa, the Shamanism of North America, the idolatry of Polynesia, and the old religions of Egypt. There has been much hard work given to this display, and great credit is due those who have been interested in its preparation.

While we speak of work done by noble individual effort and sacrifice, and without the assistance of Government or of wealthy organizations, we must describe what is done at Salem and at Davenport. No museum in America has exerted a greater influence than that in Salem, Massachusetts. A large proportion of the most active scientific men in our country, directly or indirectly, owe much of their first impulse and enthusiasm to some department of its work. In 1799 the Salem East India Marine Society was organized, with a membership confined to persons who had actually navigated the seas beyond the Cape of Good Hope or Cape Horn as masters or supercargoes of vessels belonging to Salem. Those were the palmy days of commercial supremacy and the seas were dotted with vessels from the old town. The third of the objects stated as reasons for organizing the society was "to form a museum of natural and artificial curiosities, particularly such as are to be found beyond the Cape of Good Hope or Cape Horn." The museum began November, 1799, with a gift of objects from Sumatra by Captain Jonathan Carnes. In course of time much choice material in ethnography was brought here—particularly from the South Sea Islands, China, India, Africa, and South

Frank Hamilton Cushing.

America. Meantime, the Essex Institute was gathering collections in other lines and from the neighboring district. In 1867 the collections of the two organizations were combined in the old East India Marine Society Hall, becoming the property of the new organization—the Peabody Academy of Science. The academy has gone on quietly but constantly, with little blowing of trumpets, and good work has been done. Lately an additional exhibition hall has been built, and in it are displayed the ethnographical collections. No one in America who is engaged in studying the ethnography of the South Sea Islands can afford to neglect this series. Prof. Edward S. Morse, whose chief contributions to ethnography are his paper on Methods of Arrow Release and his book on Japanese Homes, is the director of the academy, and Mr. John Robinson is in charge of the museum. Some day the story of the Davenport (Iowa) Academy of Science will be an interesting chapter in the history of science in the United States. It has never had a large donation in money, and much of its work has been done by poor men. It has had a constant struggle to survive. It is certainly fit to live, for there, with no trained anthropologist or professional ethnographer to direct or develop a definite plan of work, has grown up an excellent collection in archæology. Probably nowhere except in Salisbury, England, is there so large a series of "curved-base pipes" of stone from the mounds; nowhere else is there so interesting a series of copper axes wrapped in cloth; nowhere, except at Washington, so fine a series of pottery from the Arkansas mounds, nor many much better collections of mound crania. Nor has the academy been silent. Notwithstanding its money poverty it has published valuable Transactions, by the exchange of which it has gathered a creditable library.



Prof. O. T. Mason.

Washington has become a great scientific center, and of the whole circle of sciences none is more cultivated there than anthropology. Under Major Powell—a remarkable organizer and an indefatigable worker—has been organized the Bureau of Ethnology, with its band of workers each in some special line. Work is actively conducted both in the field and office, and the results are published as papers in the annual reports, as bulletins, or as monographs. Major Powell himself is our best authority on the Utes. For years he has been mainly interested in linguistics, and his Introduction to the Study of Indian Languages has led to the gathering of many vocabularies. The mass of linguistic material in the possession of the bureau is almost incredible. In his last annual report Major Powell presents a paper upon the Linguistic Families North of Mexico. This paper is accompanied by a map showing the conclusions he reaches. The best-known linguist in the employ of the Bureau of Ethnology is Mr. Albert S. Gatschet, whose studies are most thorough and critical. Mr. Gatschet is by birth a Swiss, and has devoted his time since 1875 to the study of anthropology and the American races and languages. Of his more important works, the earliest is the Migration Legend of the Creeks, in two octavo volumes; the original Creek text, translation, vocabulary, and critical notes upon the language and ethnology of this important tribe compose the work. Very recently the Government has published his great work upon The Klamath Indians of Southwestern Oregon, in two quarto parts. Mr. H. W. Henshaw, the general assistant in the bureau, has also collected much linguistic material, especially in California. One of the most complete studies, the results of which the bureau is printing, is that of Rev. J. Owen Dorsey among the Omahas. Mr. Dorsey has already published extensively upon the language and the sociology of this people, but he has still much material. Mr. James Mooney has made a special study during three field seasons of the Cherokees of the North Carolina Mountains, and his report upon their ceremonials has just appeared. One of the brightest workers of the bureau is Mrs. Stevenson, whose husband was one of the most indefatigable collectors in the Pueblo regions. Mrs. Stevenson's Religious Life

Hon. Thomas Wilson.

of the Zuñi Child is a very good bit of work. Two of the bureau force have been particularly interested in pictography—Colonel Garrick Mallery and Dr. W. J. Hoffman. The former was fortunately sent to the seat of the Dakota war in 1876. He there found a rude and interesting native picture record, which he published in 1877 under the title A Calendar of the Dakota Nation. At its founding, during that same year, he was invited to a position in the Bureau of Ethnology. He has continued his study of picture-writing and has investigated gesture language, and by publication and encouraging research has added much to the knowledge of both subjects. Through his Israelite and Indian (Vice-Presidential Address before the American Association) and other articles published in these pages, Colonel Mallery is already known to the readers of this journal. With Colonel Mallery, Dr. Hoffman has been much interested in picture-writing, but he has also written upon a wide range of subjects in ethnology, archæology, and folk lore. His most important contribution is The Grand Medicine Society of the Ojibwas. W. H. Holmes is an artist, and his papers upon art in pottery and textile fabrics are among the most delightful in American archæology. Mr. Frank Cushing, as a village boy in western New York, was a hunter of Indian relics on the old village sites of the Iroquois; invited to the Smithsonian Institution, he was sent to New Mexico to study Pueblo life. The story of his life at Zuñi, his adoption, his initiation into mysteries, his conduct of an "aboriginal pilgrimage" to the Ocean of Sunrise, has been told and retold in magazine articles. At the establishment of the Hemenway Southwestern Archæological Exploration, in January, 1887, Mr. Cushing was placed in charge of its work and conducted it for two years, first in the Salado and Gila Valleys in Arizona, and later at Zuñi and its neighborhood. Two years of such work brought on a serious illness, from which Mr. Cushing is only now recovering. Some results of his work were published in the report of the meeting of the International Con-

Dr. J. Walter Fewkes.

gress of Americanists for 1888. From these years of experience Mr. Cushing has gained a stock of information, little of which has yet been published. At present he is again officially connected with the Bureau of Ethnology. We have only suggested the work of this bureau, and have not even mentioned some workers who have done good work.

Adolf F. Bandelier.

The collections made by Government workers go to three museums—the material in physical anthropology to the Army Medical Museum, that in ethnography to the United States National Museum, and that in prehistoric archæology to the Smithsonian Institution. The Army Medical Museum is a great collection, beautifully arranged. There is much material here to interest the anthropologist—many fine anatomical specimens; a wonderful series to illustrate the effects of gunshot wounds and their healing; a goodly number of monstrosities; most important of all are the skeletons and crania of North American tribes—more than two thousand of the latter.

Prof. Otis T. Mason is in charge of the ethnological treasures at the United States National Museum. He is a most systematic worker, and his card catalogue of references to literature of ethnography is well worthy of study. His annual summaries of anthropological progress are exceedingly valuable. More than any other American ethnographer he has carefully studied casing, display, and labeling. Where, as in the Eskimo series, the material from any given region or tribe is large in amount and varied in character, the arrangement is geographical. In general, however, the idea in the arrangement is to show culture history. This idea, so admirably carried out in Oxford, is scarcely found elsewhere in American museums. Some of the series are excellent; the development of the knife, the history of musical instruments, the history of fire-producing instruments are good. Some cases tell the story of a whole technique; thus the case of Guadalajara (Mexico) pottery shows by specimens and by small figures of potters at work every step in the manufacture. A point that

Prof. Mason particularly wishes to emphasize is the way in which primitive man works. Thus he is not content with securing the various fire-making machines, but he must have Mr. Hough demonstrate their use by actually making fire with them. So he has encouraged Mr. Maguire to illustrate how stone tools were made by making them. One is astounded by the vast collections in this museum—there is a bewildering wealth of material. All that is received is divided into three series—the smallest is displayed in cases; the second, much larger and wonderfully rich, is placed in drawers for students to use; the third is stored away for purposes of exchange. The museum publishes its own Transactions, in which many valuable monographs appear.

The Curator of Prehistoric Anthropology of the Smithsonian Institution is the Hon. Thomas Wilson, who at one time represented our Government in Europe. While there he had unusual opportunities for field-work in the famous localities, for study of museums, and for acquaintance with the workers. He has charge of a vast mass of material. Here are surface-found specimens from every State in the Union; the beautiful objects from the mounds which supplied the illustrations for Holmes's Art in Shell; the famous copper plates from the Etowah mounds; the Perkins collection of copper implements from Wisconsin; the Latimer collection of stone implements from Porto Rico; good series from Mexico, Yucatan, and Central America. Here, too, are the results of Dr. Cyrus Thomas's mound explorations and Warren K. Moorehead's deposit. A large space is devoted to Mr. Mindeleff's wonderfully natural and interesting miniature reproductions of the pueblos of New Mexico. There is, in fact, such a wealth of material that one is confused by its very abundance. Mr. Wilson has done a very wise and instructive thing in arranging "synoptical cases." These are table-cases, placed in two groups, one on each side of the entrance-door. In one is given, by a few carefully selected, carefully labeled, and illustratedly explained specimens, a synopsis of the prehistoric

Mrs. Zelia Nuttall.

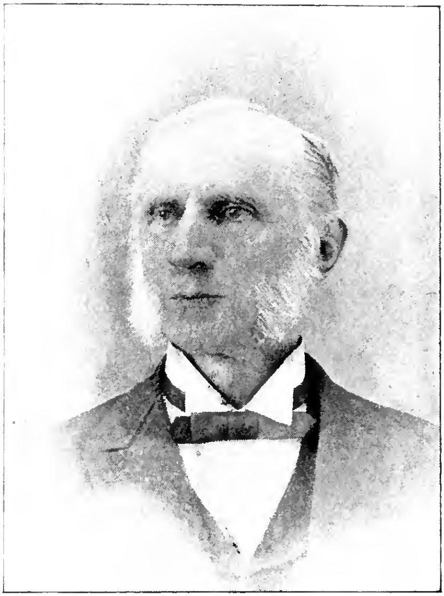
archæology of Europe, the arrangement following De Mortillet's classification. In the second group of cases a similar synoptical arrangement illustrates American archæology. As to the general collection, it is arranged strictly on a geographical basis, specimens from one State being together. Under this grouping a sub-classification according to form or type is carried out. One important work undertaken by Mr. Wilson deserves mention. From specimens in the museum a series of about one hundred has been selected, from which copies in plaster have been carefully made. One hundred such sets of casts have been prepared, and printed labels accompany them. These sets of casts are to be distributed to various institutions of learning in the United States, and considerable public interest in archæology should be the result.

Miss Alice C. Fletcher.

To complete our sketch we must refer to some individual explorations or work, and to anthropological periodicals. The Hemenway Archæological Exploration has been mentioned. This important work is supported by Mrs. Hemenway, of Boston. At present Dr. J. Walter Fewkes is the director of the work, which is centered upon the living tribes in the Moki pueblos. Dr. Fewkes is admirably qualified for the task, as he has had a thorough training in scientific methods of study. His field-work is excellent, and his own taste leads him to investigate the exceedingly interesting but difficult subject of the significance of the religious-dance ceremonials. Dr. Fewkes is perhaps the first scientist who has used the phonograph in taking down the religious music of a barbarous tribe. He has gathered considerable Zuñi music in this way, which Mr. Benjamin Ives Gilman has studied carefully. The results of this study as well as those of Dr. Fewkes's own work are published in the Journal of American Ethnology and Archæology, the official organ of the exploration. Work in the Southwest presents many attractions, and a recently organized expedition under, Mr. Warren K. Moorehead, is now in the field. This expedition is, we believe, the child of a

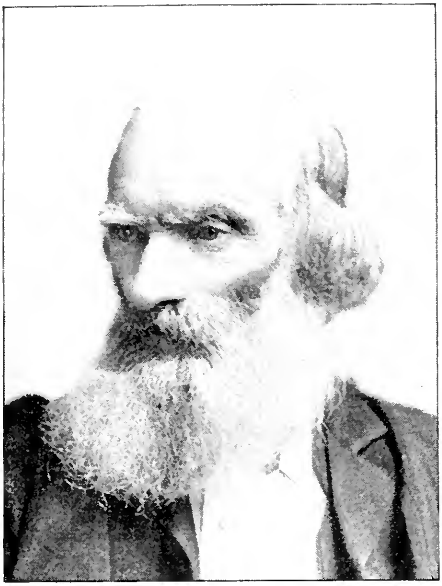
New York journal—the Illustrated American. Its object is a thorough study of the cliff-buildings of the Colorado district. Mr. Moorehead is one of the most enthusiastic of our young archæologists, and has already done admirable work in Ohio mound exploration. He was for some time with Mr. Wilson at the Smithsonian Institution, and has recently been making some remarkably successful excavations for the World's Fair. The Colorado expedition started February 29th, and is to be in progress for some months.

Mr. Ad. F. Bandelier, by parentage a Frenchman, is one of our most scholarly and critical students in that most difficult field —Spanish America. He has been markedly successful both in field-work and in study of the old Spanish records. Following the line of criticism so ably used by the late Lewis H. Morgan, Mr. Bandelier has destroyed much of the romance of Aztec and Peruvian history; but from the ruins he has reconstructed pictures of these most interesting societies that are lifelike, and far more in accordance with the genius of the American race than the old ones. His papers—at first published in the annual reports of the Peabody Museum, but latterly in the publications of the American Archæological Institute—are models of scholarship. Mr. Bandelier is now planning an important exploration into Peru-Ecuador. It is to be hoped that he may have no difficulty in finding the financial support that he needs.



Rev. S. D. Peet.

Two ladies are doing remarkable work in American anthropology. Mrs. Zelia Nuttall works in the same field as Mr. Bandelier. Although an American, Mrs. Nuttall lives at Dresden, Germany. She surrounds herself with an Aztec atmosphere; her library, one of the richest in Mexican works in existence, is cased in pieces of furniture whose forms and decorations are drawn from Mexican architecture. On all relating to Mexican archæology and history she is an authority. Two of the Peabody Museum monographs are by her—one upon a curious feather head-dress, the other upon the Mexican throwing-stick, or *atlatl*. Recently Mrs. Nuttall had the pleasure of discovering at the old castle of Ambras (Germany) a fine shield of ancient Mexican feather-work. In the last number of the Internationales Archiv für Ethnographie she publishes an exhaustive and handsomely illustrated article upon the subject of feather shields from Mexico. In a recent visit to Florence, Italy, Mrs. Nuttall discovered in the library an Aztec manuscript with pictures. It turned out to be a treatise upon dress and ornament, and contains a text in Spanish letters. This, reprinted in fac-simile, with critical notes and an English translation, Mrs. Nuttall will present at the next congress of Americanists in October. Miss Alice C. Fletcher, although a fellow of Harvard University, assistant of the Peabody Museum, and employed in the Indian Bureau, is really a free lance in American ethnology. She is more—she is a firm friend of the Indian, and has shown herself so in many, many ways. As special Indian agent she has personally located five thousand Indians upon their own lands under the "Land in Severalty Bill." Her studies in sociology and religious beliefs among the Ponkas, Winnebagoes, etc., have been scientifically carried on. She is about to publish a work upon Ponka music, that has occupied much time and hard labor during several years back. All who know Miss Fletcher or who are acquainted with her work expect this work to be a most valuable contribution to knowledge.



Sir Daniel Wilson.

Three periodicals in America busy themselves with anthropology—the American Antiquarian, the American Anthropologist, and the Journal of American Folk-lore. The Journal of American Folk-lore is the organ of the American Folk-lore Society, and is under the editorship of Mr. W. W. Newell. The American Anthropologist has grown out of the Anthropological Society of Washington; it is coming to be more and more a representative journal of our national work in the field of anthropology. The American Antiquarian deserves a longer notice, because it is the pioneer journal. Mainly occupied with American archæology, it has always been open to papers in other departments. From the beginning it has been under the editorship of the Rev. Stephen D. Peet, who has worked hard to put it where it now is, and who deserves hearty support in an undertaking which has never been a money success. Mr. Peet has himself been a field-worker and an original thinker. His field of labor is one that was for years left almost untouched, although none is more interesting—the effigy mounds of Wisconsin. Years ago Dr. Lapham prepared a work on the subject, which was very creditable for that time. Mr. Peet has gone over the same ground, and has resurveyed the groups. But he has done much more: he has surveyed many new groups, has made a careful study of the animal forms represented and of their attitudes, and has tried to work out their significance. The theories he suggests are certainly entitled to consideration, and his study deserves recognition and higher praise than it has yet received.

Nor are our Canadian neighbors neglecting anthropology. Sir Daniel Wilson's works, Prehistoric Man and Prehistoric Annals of Scotland, were training-books for the present generation of scholars. Very recently he has added an interesting contribution to a curious field in his little book Left-handedness.

Another veteran worker whom we love to recognize is Horatio Hale, who, half a century ago, went around the world as the ethnologist of the Wilkes Exploring Expedition. Of him Dr. Brinton, in the dedication of his recent little book on Races and Peoples, justly says, "His many and valuable contributions to linguistics and ethnography place him to-day among the foremost authorities on these sciences." Both, in advanced years, preserve the zeal for scientific progress, which shows itself in the planning and directing of anthropological investigations, in the founding of collections such as those of Toronto University and the Canadian Institute, and in the development of such students as David Boyle and Mr. Chamberlain. This archæological collection of the Canadian Institute at Toronto is a surprisingly rich and interesting one, and the annual reports regarding it are becoming valued contributions to archæological literature. In one of the more recent of these reports Mr. Chamberlain presents a valuable bibliography of Canadian work in anthropology—a long list of valuable papers. We only regret that we have not the space to refer to some of them and to their authors in detail.

Such, briefly sketched, is some of the work Americans are doing in the great field of anthropological science.

PHYSIOLOGY AND THE PREVENTION OF DISEASE.

By Dr. J. M. RICE.

THAT disease is far more prevalent than our knowledge of prevention justifies can hardly be doubted. An inquiry into the cause of this evil, as well as into the manner in which it can be removed, is therefore, in my opinion, not inopportune.

With few exceptions, that which is done at present for the prevention of disease is limited to improving the sanitary conditions surrounding the individual, in consequence of which two very important factors are left out of consideration: Firstly, that many diseases are caused by unfavorable internal conditions, which for the most part can be traced to imperfect development and improper modes of living; and, secondly, that exposure to unfavorable external conditions is not necessarily followed by illness, for the reason that the body itself offers a certain amount of resistance to the same. Unless, therefore, our efforts be extended to the prevention of diseases arising from internal causes as well as to increasing the power of resistance, they must to a considerable extent remain inefficient.

As the means employed for the purpose of improving the surrounding conditions are well known, it will be unnecessary to enter into detail here regarding them. The deleterious substances in the outer world are principally germs and other impurities of various kinds in the atmosphere and food. That diseases arising from such causes have considerably diminished during the past few decades, owing to the attention given to isolation, disinfection, antisepsis, sewerage, cleanliness, ventilation, etc., is unquestionable.

The remaining elements in prevention, namely, the regulation of the internal conditions and the increasing of the power of resistance, are so intimately connected that they are furthered by the same measures.

Although the conditions upon which the power of resistance depends are for the most part obscure, physicians agree that, other things being equal, an individual is strongly guarded against disease when he is in good health, and that resistance diminishes when the vitality becomes lowered. Now, in order that there may be good health, *normal functional activity of all the organs* is essential. By endeavoring to secure good functional action, therefore, we do all possible for increasing resistance to disease caused by unfavorable external influences; but, in addition, we obviously aid in the prevention of functional derangements which, together with their consequences, constitute a large percentage of all diseases.

But where shall we look for guidance if we desire to learn how normal functional activity can be attained? Naturally, to the science which treats of the bodily functions, *physiology;* and we shall see in a moment that by the application of physiological principles, not only will the organs be temporarily aided in the performance of their functions, but, if continued, good physical development, that condition upon which permanent health depends, will be secured. Therefore, physiology is, as well as bacteriology, to a certain extent a science of prevention, but, in our eagerness to catch and exterminate germs, it has been pushed far into the background, though so much nearer home to us than the latter.

That physical development is an important element in the maintenance of health becomes obvious when we consider that, other things being equal, an organ performs its functions in proportion to its strength; hence, if all the organs be well developed, all the functions will be thoroughly performed.

But good physical development is the result of adequate nourishment of all parts of the body, and such nourishment depends upon the proper performance of all the functions. That this does not lead us into an absurdity becomes evident when we consider that imperfectly developed organs may *with assistance* perform their functions efficiently, and physiology points out how this aid can be given. *In consequence of this help,* therefore, the organs develop and perform their functions properly with ever less assistance, and the condition of perfect health is gradually approached.

Now, if we assist the organs during childhood when they are weak, not only will much be done to secure good health during this period, but the age of maturity will be reached with a well-developed body, and good health, therefore, to a considerable extent assured through life. It is true that, under ordinary circumstances, a smaller body can be nourished, with weaker organs; but if as early as the sixth year a child begins to labor from five to seven hours daily the conditions are entirely changed. During childhood a large quantity of nourishment is required for growth alone, and, if a good share of this be expended in labor, it is clear that, unless something be done to compensate for this unnatural state of affairs, when the period of growth is over the body will be imperfectly developed, with very little chance of recovering the lost ground. When this is the case, the individual will be liable to be afflicted with poor health ever afterward; how often it now occurs is but too well known.

As to the means for assisting the organs in their labor, none is so powerful as *muscular exercise.* This agent not only plays an important part in the general nutrition of the system, having a favorable effect upon all the functions which take part in the changes through which the food must pass before being converted into tissue, namely, digestion, absorption, circulation, oxidation, and assimilation; but it likewise aids in preventing derangement of these functions—that is, a large number of diseases. The following *résumé* of the effects of exercise will show that its value has not been overestimated:

First. Muscular contraction exerts a pressure upon the veins and lymphatics, thus pushing forward and facilitating the flow of venous blood and lymph to the heart. In this manner the excretion of the products of tissue waste is enhanced. These matters are washed out of the tissues by the blood and lymph, and after their return to the heart pass through the lungs, where the carbonic acid is given off, then through the general circulation, the remaining substances being eliminated by the skin and kidneys. When these matters, some of which are highly poisonous, collect in abnormal quantities in the system, they become more or less dangerous; even such mild symptoms as headache, drowsiness, and general lassitude in those who lead a sedentary life may probably, in many instances, be traced to their toxic effects. By muscular exercise, which hastens the elimination of these substances, therefore, many slight ailments, which, however, are sufficient to make labor burdensome and rob life of many of its pleasures, may be avoided.

Second. The circulation is controlled mainly by the action of the heart. When the activity of this organ is increased, therefore, the general circulation will be improved. Now, the heart is stimulated to action by the presence of blood in its cavities, and muscular exercise, by hastening the flow of venous blood, will be instrumental in sending more fluid through them in a given period of time, and consequently in stimulating the organ to increased activity. As many diseases, prominent among which are those of the abdominal and pelvic organs, are the consequences of congestion, and as good circulation does much for the prevention of such congestion, muscular exercise, by improving the general circulation both by increasing the activity of the heart and aiding in the venous return, will do much to prevent a large class of diseases.

Third. The respiratory center is increased in activity when the blood is more venous than usual—that is, when the amount of oxygen is diminished and the carbonic acid increased. Now, as an organ consumes more oxygen and gives off more carbonic acid when it is actively engaged in the performance of its functions, it follows that exercise exerts a stimulating effect upon respiration by making the blood more venous. When the activity of respiration increases, a larger quantity of oxygen enters the system;

and it has been calculated that this extra supply more than compensates for that expended in exercise—a circumstance which is readily understood when we consider that during muscular action more blood passes through the lungs, thus coming in contact with more oxygen. An increased supply of oxygen enhances the oxygenation of the food, thus directly facilitating the development of energy; and, besides, oxygen being a heart stimulant, the circulation will again be favorably affected.

Fourth. Assimilation becomes furthered by muscular exercise, for the reason that more blood passes through an organ during its activity, and consequently the latter becomes enabled to absorb more nourishment and lay by a larger quantity of reserve force.

Fifth. The blood, becoming more rapidly freed of its nutrient material by increased rapidity of assimilation, will be more ready to absorb such matters from the digestive organs. Improved absorption leads to more perfect digestion, and consequently muscular exercise aids considerably in the prevention of digestive disturbances. Further, when the digestion is enhanced, more food is called for. Increased appetite, together with improved digestion, absorption, oxidation, and assimilation, naturally exerts a marked influence upon the general nutrition of the system; therefore, exercise is a powerful means to the prevention of so many diseases caused by malnutrition.

Sixth. Muscular exercise by its direct effect upon the muscular system is the means not only of developing an active as well as a strong and healthy body, but likewise of storing up a large quantity of reserve force.

But, in order that muscular exercise may result in good physical development, *it must be carried on systematically for a long period*, and especially, for reasons already given, during the years of childhood. The *nature* of the exercise plays by no means an unimportant part in its efficacy. In order that all parts of the muscular system may be brought into play, gymnastics and calisthenics are indispensable. These exercises, however, should be supplemented by outdoor sports, such as games, rowing, swimming, skating, and the like, for two reasons: Firstly, the latter contain an element of pleasure without which that exhilaration which makes exercise doubly valuable is apt to be wanting; and, secondly, the air inhaled at the time is purer than that in closed rooms, an advantage which can not be overestimated.

But how can good physical development be placed within reach of all children? Only in one way, namely, *by the introduction of effective methods of physical exercise into schools*, for the reason that during the greater part of childhood systematic work outside of these institutions is, in the vast majority of cases, entirely out of the question.

In our search for means of preventing disease we have been led, as we see, beyond the province of medicine and into that of education. But the connection between these two fields, from our standpoint, extends much further, as we shall find. Though muscular exercise be carried to the point of perfection, and the surrounding conditions leave nothing to be desired, health is not assured; for, should the *expenditure of energy* be too great, there will still be marked interference with development. Hence, the *expenditure as well as the development of energy* must be considered.

Now, the energy is expended by the organs in the performance of their functions. Though ultimately derived from the food, its proximate source is, at least in great part, the tissues, which, by undergoing combustion, furnish the required energy; whether it be all derived in this way, or whether it be in part supplied immediately by the blood, is a matter which has no influence upon our problem. It is essential, however, to bear in mind that the amount of energy which can be developed in a given space of time is limited to the quantity of food digestible during this period, and, *if it be expended more rapidly than it is thus supplied, the functions are performed at the expense of the tissues.* If, therefore, we desire to guard the system against waste and allow the organs to develop properly, we must, as far as possible, *limit functional activity.* There are, however, only two functions over which we can exert a direct voluntary influence, namely, *the muscular and the mental.* But as there is ample compensation for the energy expended in muscular activity while there is none, in the physical sense, for that used in mental action, it is clear that if we desire to economize we must do so by exercising control over *mental labor.* That the energy expended by the brain during its activity is derived from the same source as that required for the performance of the other functions is, to-day, a generally accepted fact.

But, in order that it may not interfere with physical development, mental labor must be regulated both quantitatively and qualitatively.

In regard to quantity, the number of school hours must not be excessive; and introduction into school life should be gradual, so that the labor may be in proportion to the age and strength of the child. In Germany this rule is observed, the children beginning with about sixteen hours per week, to which two are added every year until the fifth or sixth, when the maximum is reached. The amount of work required at school, and in the preparation of lessons, likewise needs careful consideration.

From the qualitative standpoint the methods of instruction play an important part. When the laws of psychology are observed, the mind being treated in accordance with its nature, the channels of least resistance are used, and the greatest amount of labor performed with a given amount of energy.

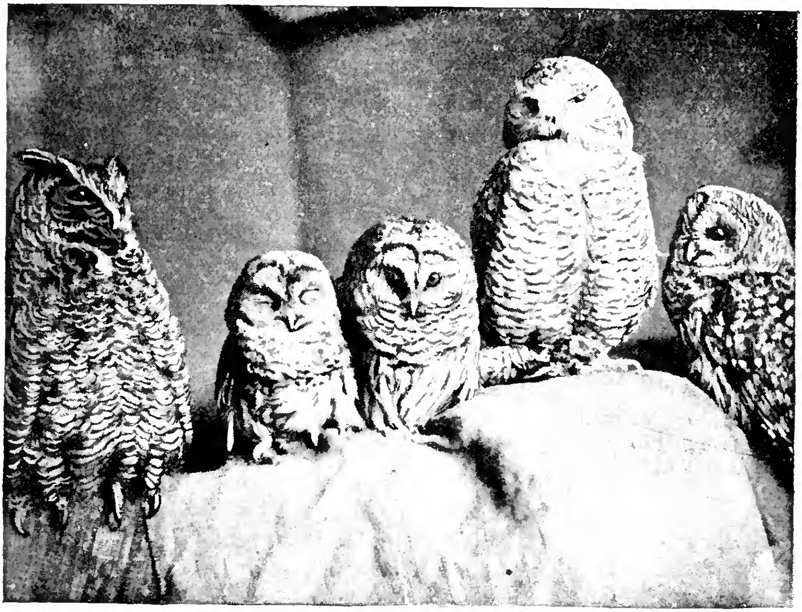
As long, therefore, as physical exercise is grossly neglected, and unpsychological methods of teaching remain in general use, disease must continue in abundance, though ever so many improvements be made in sewerage, ventilation, and disinfection; for, as our argument has shown, attempts at prevention will in great part remain ineffectual until good systems of physical and natural methods of mental development have been introduced into the schools.

WAYS OF THE OWL.

By FRANK BOLLES.

SINCE June, 1888, I have had in my possession for longer or shorter periods eleven live owls, including snowy, great-horned, long-eared, barred, and screech owls. I have also had opportunities of watching Acadian and screech owls in a wild state. In June, 1888, I secured two young barred owls from a hollow beech tree in a White Mountain forest. I have them still after three and a half years of happy companionship. During the first summer they were pets not easily petted. They used beak and claws fiercely and resented familiarity. I kept them in a large slatted cage in my barn, where they had plenty of air and light. They bathed freely and frequently. They ate largely of animal food. They were awake by day, restless at twilight, but profoundly quiet by night. They could see perfectly in bright sunlight, and better at night than most creatures. In the autumn I took them to Cambridge, where they were given a large cage in my cellar. During the winter I handled them more and more freely, beginning by using stout leather gloves, but soon stroking and rubbing their heads with my bare hands. They became more and more gentle, and I found that even when they nipped me with their beaks they did not attempt to cause serious pain. One of them, whose name is Puffy, injured his wing early in his captivity, and has never been able to fly. The other I keep clipped in one wing. In the spring of 1889 I began taking Puffy with me on walks. I found at once that he was wonderfully useful in attracting other birds. During the summer of 1889, the following winter, and the summers of 1890 and 1891 he was my companion on walks, drives, and trips in my Rushton boat. To a smaller extent I have taken his mate Fluffy with me, but he is of a less patient disposition than Puffy, and during a long walk is sure to hop from the stick upon which I carry him many more times than Puffy would in an equal period. In May, 1891, I secured a third baby barred owl from the same beech tree. From the first hour that he was imprisoned he has shown an irritable temper. His whining as a young bird was incessant by day and not always suspended by night. Now, at the age of nine months, he whines whenever any one approaches him, and frequently makes violent assaults upon me when I enter the part of my cellar in which the owls are penned. Puffy and Fluffy during their first summer were quite timid, and Fluffy is an arrant coward now; but Prince Edward, as the new captive has been named, has never shown fear of anything living or dead, large or small.

Of two fully grown screech-owls which I owned, one in the spring of 1890, the other in the spring of 1891, little is to be said.



GREAT-HORNED. PRINCE EDWARD. PUFFY. SNOWDON. FLUFFY.

They were unhappy, and, although they ate well, both died from the effects of pounding their heads against wire netting in efforts to escape. These owls, when approached, stiffen their ears, make their feathers lie closely against their bodies, keep every joint and muscle rigid, and so nearly close their eyes that only an expressionless slit remains through which they watch the intruder. To the gentle caress of a hand they pay no heed. I have often taken one of them in my hand, laid him upon his back, and so carried him from room to room, and not been able to detect the movement of a feather. Let, however, the intruder retire, or let him take a dead mouse from his pocket and draw it by a string across the floor, and Scops is himself again in a twinkling. The ears are lowered, the bright eyes open wide with a wicked glare, and the soft wings take the crafty and cruel little bird swiftly down upon the mouse. This habit of shamming unconsciousness appeared to be characteristic of the long-eared owl which was mine for a few brief hours in October, 1891. I handled him freely, but the closed eyes and rigid muscles did not move. I went away and watched him from a distance, and he was alert and making full use of his beautiful eyes.

Early in the summer of 1890 a friend sent me three young screech-owls. They were as odd little gray hobgoblins as could be imagined. Their temper, their voices, their appetites—all needed superlatives to describe them. They were sent to the White Mountains for the summer, and lived in a slatted box under the barred owls' big cage. They loved mice, birds, and fish, but did not take quite as kindly to raw liver as the barred owls did. For a week or more two of them were taken away from the third, and when they came back they no longer knew him as a brother. His life was made a burden to him, and one morning in August I found his body lying on the floor of their cage. They had removed nearly all his feathers and would probably have devoured him if I had not deprived them of the fruits of their unnatural crime. A few days passed and the two murderers quarreled over a mouse. In the frequent struggles that followed, one was killed outright and the other survived but twelve hours. My efforts to tame these young screech-owls were only partially successful. The murdered one had taken one or two excursions with me, and while I walked clung to a stick carried in my hand, or nestled between my arm and my body. If placed in a tree he served quite well as a decoy, although perhaps some species of birds did not take him as seriously as they did the barred owls when those intruded upon their breeding-grounds.

In June, 1891, I was presented with Snowdon, a full-grown snowy owl, which had been captured during the preceding winter. He was a dangerous-looking bird, with a temper and a trick of jumping for one's fingers. I clipped one wing and began by handling him roughly if he showed a disposition to fight. At the end of a week he learned to step upon a stick and cling to it while I carried him back and forth in the cellar. Taking him to the White Mountains, I gave up to his use a box stall in the northeast corner of my barn, and kept damp Iceland moss for him to stand upon, plenty of water for him to bathe in or drink, and a moderate supply of food for his sustenance. Although we had some warm weather, he was in perfect health throughout the season, and is now in excellent condition. At first I kept the barred owls away from him, fearing that they might murder each other, but later experiments showed that Snowdon had no ill feeling toward the barred owls, and ignored them even when they stole his portion of the food. It is now six months since I turned them in together, and during the whole of that time the four birds have been on terms of quiet indifference.

About the middle of September, 1891, a Boston dealer sent me a mature great-horned owl. He reached my country place just in time to be sent back to Cambridge with the snowy and barred owls. Clipping one of his great wings, I placed him with the others in the 250 square feet of cellar space fenced off for them. Puffy prepared for war, Fluffy fled, Prince Edward regarded the stranger with indifference, and Snowdon and the great-horned formed an alliance at once. Three months have passed, and, so far as I know, no conflict has occurred. The older barred owls fear and dislike the great-horned. Prince Edward treats him with brassy familiarity, and Snowdon stays with him in the corner of the cellar farthest from the favorite perch of the barred owls.

Great-horned on a Stump.

Having introduced my characters, I will now compare them in several particulars. They arrange themselves, when I think of them as owls merely, into two groups—the brown owls and the gray owls. The great-horned, long-eared, screech, and Acadian owls seem to me much alike in disposition and their way of meeting man. They seem like kindred.

The barred and snowy owls, while quite different from the brown owls, are somewhat alike in temper. They show fight when approached, and are very alert. The barred owls make several different sounds expressive of various emotions. They snap their beaks furiously when warning an enemy; they whine when hungry; they make a soft, rather musical "ōō" when meeting after an absence; they chatter with rage when pulling in opposite directions on the same bird or mouse; and they hoot when expressing the sentiments which make the domestic cock crow. While young they make a queer chuckling chatter when cuddled, and as the sound grows faint it suggests the music of a brood of chickens nestling under their mother's feathers. The hooting varies. In the August twilight I often hear the loud trumpeting "hōō" uttered at intervals of half a minute or more by wild owls in the woods. The common hoot, which suggests to some ears feline music, is generally "hoo-hoo hoo-hŏŏ, hoo-hoo hoo-hōō," but I heard a barred owl this winter in a remote White Mountain valley say "hoo-ŏŏ, hoo, hoo, hoo, hoo, hoo, hoo-ōō." He was a conversational and inquisitive bird. By hiding in some evergreens and hooting to him I drew him little by little to the tree-top just above me.

Wholly different is the conversation of the snowy owl. His warning is sometimes beak-snapping, but oftener an open-mouthed, hissing "āh," which has a most menacing quality. He occasionally utters a shrill, whistling scream expressive of pain or the fear of pain, yet he makes it also when snatching a morsel of food held toward him. Thus far I have heard my great-horned owl make but four sounds: terrific beak-snapping; āh-ing quite equal to Snowdon's; a hooting which suggests wind sighing in a hollow tree, and taking the form of "whōō, hoo-hoo-hoo, whōōō, whōōō"; and a series of soft, musical notes, rolled from his throat when Snowdon comes too near his clutched breakfast.

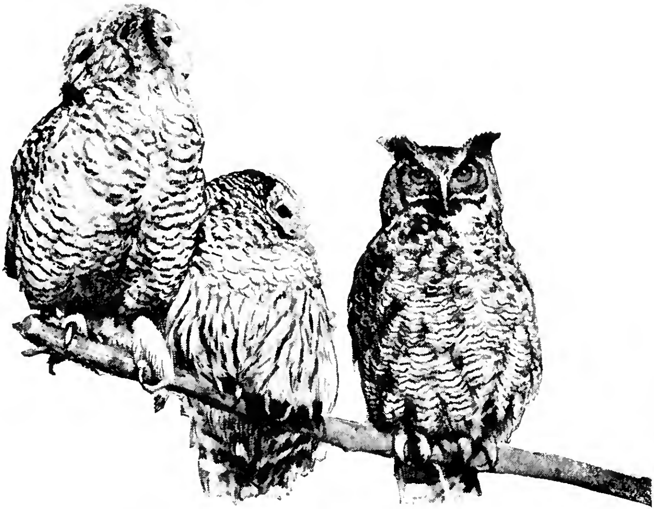
My barred owls eat raw butcher's meat, mice and squirrels, bats, any kind of bird, hawk and crow included, fresh fish, lake mussels, snakes, turtle-meat, some species of frog, earth-worms, some kinds of insects, and hen's or bird's eggs. They will not touch toads or the frogs which secrete an offensive scent. They rarely eat tainted meat or stale fish. Once they played for hours with a dead weasel, much as a cat plays with a mouse, but they did not eat any part of it. They catch living fish from a tank, and kill mice, squirrels, birds, frogs, and snakes; but they were at first greatly alarmed by a turtle, and a young hare running around their cage frightened them almost into fits. Puffy will face and put to flight a cat or a dog, but a pig is a terror to him. When Puffy was only six months old he caught and killed a two-pound pullet, yet in March and April, 1891, he roosted night after night on the same perch with an old Cochin hen which had begun her stay in his cage by giving him an unmerciful trouncing.

SNOWDON ON A SNOW-COVERED STUMP.

So far as I have been able to ascertain, Snowdon will not kill anything, no matter how hungry he may be. He eats dead birds, mice, squirrels, fish, snakes, mussels, turtles, if opened, and butcher's scraps; but he will make no effort to catch or kill a squirrel, mouse, or snake, although shut up with them while hungry for a day or more. In one instance of this kind he ate a squirrel which he had allowed to live for twelve hours, as soon as it was killed and given to him. I have seen him drink once, and only once. If he bathes, it is a rare occurrence and done secretly. Early one morning in August, 1891, I heard a splashing in the owl's water-tank. It was about 3.30 A. M. Creeping to the cage, I peered in, and saw Snowdon shaking himself, as though he had just finished a bath.

His method of eating is suggestive of a carrion-eater. The barred owls are deliberate in their way of treating their food. They search for and crush joints and finny projections. In a frog they feel of every limb from end to end, and crunch away at the joints until they are mellow. They generally pull out the stiff wing and tail feathers, even in quite moderate-sized birds. Small snakes they swallow squirming. Snowdon, on the other hand, ignores live snakes, and his first act with dead food is to swallow it whole if he can possibly distend his throat far enough to let it pass. I have seen the head of a large rooster vanish down his throat bill foremost without his making any effort to crush it. Often a piece of food will stick in his throat and refuse to go down, in spite of vigorous jerks, jumps, and convulsive swallowing. It is then ejected and sometimes dropped altogether. With a large piece of meat or fish his method is different. Standing upon it, he snaps at it viciously and tears off small bits, in eating which he makes a smacking noise. Engaged in this way he is a disgusting spectacle. His head is poked forward, and the feathers upon it seem flattened. The hairy feathers around his beak are drawn back, and his red mouth is open much of the time. If disturbed while eating, he makes his shrill and extremely piercing cry. He is perfectly willing to be fed by hand, snapping at and bolting morsels of liver as fast as they are passed to him. He sometimes eats enormous quantities of food in a short time. He ate the whole of a full-grown bittern in twenty-four hours, and on another occasion a cooper's hawk placed before him at night had only one leg and a few feathers remaining in the morning. Like other owls, he ejects hair and bone pellets from his mouth.

The great-horned owl is not so ready to be fed. He prefers to eat while alone. Mice, however, are too attractive to be refused, and whenever held before him are slowly and quietly taken and swallowed. Other food he usually pretends not to see until I have left him. He seems ready to eat anything that the other owls like. I know that he has bathed at least once this winter, and, judging by his plumage, he uses water freely. When given a cod's head or a large bird, he stands upon it and tears off morsels much as Snowdon does. His motions in doing this are sudden and his whole expression fierce and tiger-like. With horns slightly flattened and eyes glaring, he first plucks a piece of flesh from the carcass and then turns his head sharply from side to side to see whether any other owl dares to intrude upon his repast. My

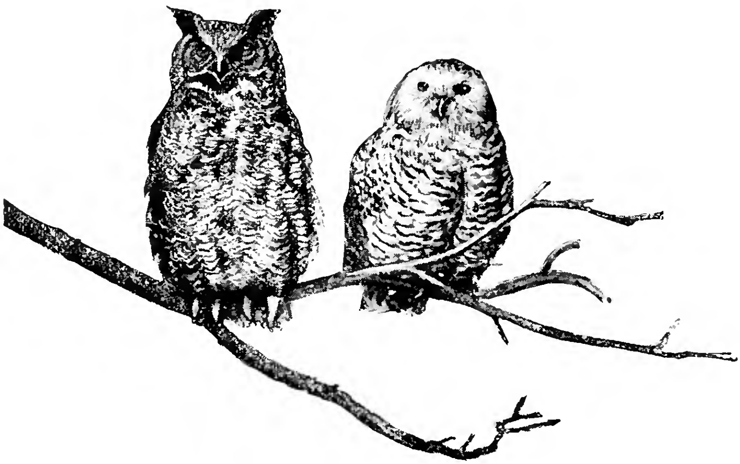


SNOWDON. PUFFY. GREAT-HORNED.

barred, snowy, and great-horned owls all feed freely in the daytime. My screech-owls, on the contrary, usually waited until dark before devouring their food. One of them apparently ignored a live English sparrow for several hours while daylight lasted and the sparrow was able to see him, but when night came the sparrow was speedily caught, plucked, and eaten.

The feeling with which other birds regard an owl seems to be a mixture of curiosity, hatred, and fear. Curiosity impels them to approach, hatred causes them to make violent and abusive cries, while fear inclines them to wariness and prevents them from open attack upon their sphinx-like enemy. This feeling of the birds is general, almost universal, and is shared in a modified form by the smaller owls when brought in contact with large ones. To the chickadee or the warbler it makes no difference whether an owl is large or small; he is an owl, and that prompts inspection and vituperation. In several instances I have found Acadian owls in the woods in consequence of the racket made by birds scolding them. This winter, on the day after Christmas, I was walking through a spruce thicket in Albany, N. H., when the noise of nuthatches, Hudson Bay and black-capped titmice and kinglets enticed me into the darkest part of the growth. The birds were greatly excited, and as I softly drew near them I saw that they were in a circle, all facing toward some focus invisible to me. I crept farther, and saw the tail of a small owl projecting from behind the trunk of a tree. Presently his tiny monkey face was screwed around over his back, and his timid yellow eyes fixed themselves upon me. His tormentors soon flew away, and after studying me attentively for some time the little Acadian floated off out of sight also.

The young screech-owl, whose death at his brother's hands I have already mentioned, irritated the birds of the forest and meadow in the same way. I placed him, one morning, upon a birch tree which was in use by a family of yellow-billed woodpeckers as a sap-drinking place. The sap-suckers made a great clamor on seeing him, and their cries called together all the birds which were within earshot. At least thirty individuals came, including kingbirds, cuckoos, catbirds, veeries, chickadees, four or



Great-horned and Snowdon.

five kinds of warblers, red-eyed vireos, song-sparrows, and two humming-birds. Having scolded for nearly ten minutes, they departed, leaving a sap-sucker and a humming-bird, which soon forgot the owl and resumed their usual employment of drinking the birch tree's sap.

Several times during the summer of 1891 I took my snowy owl out to walk. He weighs three and a half pounds, so the task of carrying him by hand upon an outstretched stick was rather a laborious one. The birds noticed him at once, and scolded as though he were of a species with which they were unpleasantly familiar, instead of one with which they were presumably wholly unacquainted. Thrushes of various kinds, warblers, vireos, swallows, and sparrows treated him precisely as though he had been a barred owl. Once a grouse, with a family of chicks, confronted him boldly for a moment, while her brood scattered to cover. His conduct while at liberty was somewhat peculiar. He shunned the woods, and if taken into them, quickly made his way out. His left wing being clipped, his only method of advance was by clumsy leaps, or by a queer wobbling run, aided by outstretched wings. Whenever I placed him upon the ground, he would hurry away to a distance, and stop to pant with his wings dragging wearily at his sides. One warm morning I left him on an open pasture hill-side, and walked away to a belt of woods nearly an eighth of a mile from him. Concealing myself in the bushes, I watched him closely through my glass for an hour and a half. The time was nearly a blank. The owl, satisfied that I had gone, walked toward me about a rod and sought the shady side of a small patch of juniper. There he remained almost motionless for the entire period. Sometimes he turned his head and watched crows at a distance. Once or twice he glanced at the sky, and in one instance he followed with his eyes the flight of a small bird. Looking toward the sun did not seem to affect his vision. That he could see things at a distance was shown in several ways. When I came slowly from my hiding-place he saw me at once, and started jumping down the hill away from me. On another occasion I took him out in a pouring rain, thinking that he would go to the woods for shelter. He was content with standing under a small apple tree which gave him practically no protection, a fact which he discovered and sought to remedy by running to another tree of the same kind. Inactive, unable or unwilling to kill mice or squirrels, even when most hungry, silent, vacant in expression, cowardly, apparently stupid, the snowy owl, judged by my one captive, is a dull and uninteresting member of an unusually acute family. I doubt Snowdon's being a fair type of his species.

The barred owls are the particular abomination of other New England birds. They are courageous, keen of vision by day and in the twilight, strong, alert, quick, yet crafty. Their voracity makes them the terror of every nesting mother, the scourge alike of the forest, the field, and the meadow. Of their merits as decoys there can be no doubt. If taken while young and clipped, they are readily tamed and taught to obey simple orders. Mine have been invaluable to me in studying the birds of New Hampshire. When going for a walk, I take one or both of the older ones. Entering their cage, I extend a short stick toward and on a level with their feet, and say, somewhat sternly, "Get on." They generally bite the stick once and then step upon it, and cling to it patiently while I carry them through any kind of country. When I wish to have them attract other birds I hold them toward a convenient branch and say, "Get off," which they are very willing to do. Then by whistles or cries I attract some bird's attention, and if it proves to be a titmouse, a woodpecker, a thrush, or some other excitable bird, the alarm is given, and from all quarters the neighbors come pouring in to join the tumult. Even while holding Puffy on a stick and walking with him, I have had birds attack him. Once a pair of solitary vireos followed me for some distance, one of them flying between my head and the owl three times, apparently not noticing me any more than though I had been a tree. A similar attack from a sharp-shinned hawk was more surprising than pleasant. Some species are less demonstrative than others, and seem to think silence and retreat wiser than vituperation. Cedar-birds, great crested fly-catchers, and scarlet tanagers are three species which seldom greet Puffy noisily. Game birds, as a rule, are too much afraid of me to remain near the owl, and the same is true of water-fowl. Loons have, however, shown curiosity on discovering Puffy, and sandpipers clearly dislike him. I tested this in an amusing way one day, by taking Puffy out in my boat to a point just to windward of a solitary sandpiper, and then setting him adrift on a small board. At first the sandpiper did not see him, but as the wind carried the placid owl nearer and nearer the beach, the tattler suddenly discerned him, and became stiff with astonishment. He faced the owl, his head poked forward and his body rigid, then with a wild cry he flew, rising from the water and passing over the trees, away from the lake.

Whip-poor-wills are not easy birds to watch at night, but they usually fly toward the owl, uttering excited *clucks*, and fly several times over it before going away to a distance. A mother nighthawk, with young, showed great courage and sagacity in dealing with Puffy. I placed the owl near her nest. She promptly flew down on the side of the owl away from her young, and fluttered in the grass as though wounded. Puffy hopped toward her. She flew a few feet, he followed, she flew a rod, he followed a third time. She flew three or four rods, and, as he hopped on, she rose and circled around him until, if he had seen her nest in the first place, he never could have remembered in which direction it lay.

The hooting of a barred owl in the daytime, or my imitation of the sound, almost invariably brings birds to the spot. Crows will come a long way in response to the hated call. So will blue jays, and several of the hawks and woodpeckers, hermit and Swainson's thrushes, chickadees, and a few other small birds, including the siskins in winter. Crows, in a particular region, soon learn that a barred owl implies a man in the same thicket, but for the first two or three times, hooting will surely call them within short range.

Although game birds usually avoid the owl on account of my presence, a grouse with a large brood of young on one occasion showed much courage in watching Puffy. Her chicks scattered, but she remained in sight, whining and trailing her wings and doing her best to entice the owl away from the spot. Once she came within ten paces of him, her tail spread like a fan and her wings arched like an angry hen's. Puffy paid little attention to her, but seemed to be looking for the chicks which he had heard stirring in the leaves. Whenever he hopped she rushed into view, whining. She remained near by during the whole of twenty minutes that I spent in her domain.

In July, 1891, Puffy had a face-to-face meeting with a wild barred owl. Puffy was perched upon a stump facing a hemlock forest. Suddenly he became rigid and assumed a very unusual attitude for him, his head being thrust forward and his body flattened so that his breast rested upon the stump. Following the direction of his steady gaze, I saw a fine specimen of his race in the dark forest. He was as rigid as Puffy. How long they would have glared at each other I cannot tell, for it began to rain, and the stranger flew away.

The hearing of all species of owls known to me is marvelously keen ; so keen, in fact, that I know of no way of testing it, since it is so much more acute than that of man. If owls have the sense of smell, I am unable to find satisfactory evidence of it. I have tried various experiments with them, hoping to prove that they could smell, but the results are all negative. They dislike putrid meat, but they bite it to ascertain its condition. They will not eat toads or frogs which yield an unpleasant odor, but they did not reject these species until they had tested them by tasting. They may be ever so hungry, yet they do not suspect the presence of food if it is carefully covered so that they can not see it. This test I have applied with the utmost care to the great-horned, snowy, and barred owls. The latter are shrewd enough to learn my ways of hiding their food, and when they suspect its presence they will search in the places where I have previously hidden it, pouncing upon pieces of wrapping-paper, and poking under feathers and excelsior with amusing cunning. I tested them with the fumes of camphor, ammonia, and other disagreeable and unusual smells, but they failed to show that they perceived them unless the fumes were strong enough to affect their breathing or to irritate their eyes. Finally, I put a cat in a basket and placed the basket between the two owls. They were utterly indifferent to it until the cat made the basket rock, when both of them fled precipitately, and could not be induced to go near the basket again. Although Puffy will put a cat to flight when on his mettle, Fluffy is frightened almost out of his wits by them.

A Japanese toy-bird, made of a piece of wood and a few scarlet feathers, was eagerly seized by Puffy, indicating not only a lack of power of smell, but the presence of an appreciation of color. I have fancied that an appreciation of color is also shown by barred owls in their frequent selection of beech trees as nesting-places, by great-horned owls in their choice of brown-trunked trees, and by Snowdon in an apparent preference for gray backgrounds.

To this real or imaginary ability of the owls to select protective backgrounds is to be joined an undoubted power of assuming protective shapes. My great-horned owl can vary at will from a mass of bristling feathers a yard wide, swaying from side to side as he rocks from one foot to the other, to a slim, sleek, brown post only a few inches wide, with two jagged points rising from its upper margin. When blown out and defiant, his bill is snapping like a pair of castanets, and his yellow eyes are opening and shutting and dilating and contracting their pupils in a way worthy of a fire-breathing Chinese dragon. In repose he is neither inflated nor sleek, but a well-rounded, comfortable mass of feathers. The barred owls go through the same processes of expanding and arching out their wings when awaiting attack, and of drawing all their feathers closely to their sides when endeavoring to avoid observation. In one instance Puffy escaped from me in the woods, perched upon a small beech stump, drew his feathers into such a position that he seemed a mere continuation of the stump, closed his feathered eyelids until only a narrow slit remained for him to peep through, and stayed perfectly stiff for an hour while I hunted for him high and low. I passed by him several times without bringing my eyes to the point of recognizing him as a living thing. This power is shared by the screech-owl and the long-eared owl. The plumage of the snowy owl is so solid that he seems more scaly or hairy than feathered. He does not, so far as my specimen shows, expand and arch his wings. Instead of standing straight and becoming slim and rigid, he crouches and flattens himself when seeking concealment. I can imagine him in his Labrador wilds crouching thus amid a waste of junipers and reindeer moss, and baffling the eye which sought to detect him there.

The control which owls have and exercise over their feathers is not limited to moments when they wish to appear terrible or inconspicuous. They seem to ruffle them or smooth them, expand them or withdraw them in queer ways at pleasure. The barred owls, when stepping stealthily across a floor after a dead mouse drawn by a thread, tuck up their feathers as neatly as a woman hold her skirts out of the mud. When eating, the feathers nearest the mouth are pulled aside in a most convenient way.

When wet, the feathers seem to shake themselves as well as to be shaken by motions of the body, head, and wings. My wife, in making a water-color sketch of Snowdon, complained that, although she could not see him move, he changed his outline a dozen times in an hour.

The owl's eye is his most useful member. The popular belief that the owl is seriously blinded by light is almost wholly unfounded, at least so far as the species of which I am writing are concerned. When a man approaches an owl in broad daylight the owl, in nine cases out of ten, will close his eyes, and so appear sleepy. As I have already explained, this is an effort to escape notice by the assumption of a protective shape. That it is not due to any dread of light or inability to see is shown by the following instances of perfect seeing by owls in bright daylight: Walking through a Cambridge road in March, 1891, I saw an Acadian owl perched on a willow limb about fifty feet from me. His plumage was stiffened and his eyes nearly shut. I approached him and slowly raised my hand toward him. Suddenly his eyes opened wide and glared at me. Then the soft wings spread and he fell forward upon them, and flew toward the sun to a distant perch. The Acadian owl already mentioned as having been seen in December, 1891, in the spruce forest of the Swift River Valley, watched me keenly, and swung his small head around after the manner of owls, trying to see me clearly from more than one point of view. The screech-owl which I first owned, although shamming sleep one morning when I entered the room where I kept it, pounced upon a dead mouse which I let fall upon the floor, and flew off with it before I realized what had happened. One of my three young screech-owls when only two months old tried to catch a sap-sucking woodpecker which had perched near it in the sunlight on a dead tree. My snowy owl, as I have already stated, watches birds flying across the sky at a distance, and once saw me as I slowly emerged from the woods an eighth of a mile from him. Great-horned owls are well known to be active by day, and not inconvenienced by sunlight. The barred owls, however, exhibit the most marvelous powers of sight, and their eyes may well be called telescopic. In dozens of instances Puffy has seen, and by his fixed watching of the sky has called my attention to, hawks flying at so great a height that they were well-nigh beyond man's vision. More than this, he has on two or three occasions seen a hawk approaching in the upper air when my eyes, aided by a fairly strong glass, failed to see the bird until it drew nearer and grew large enough for me to detect it as a mere dot in the field of the lens. My eyes, by the way, are rather stronger and more far-sighted than the average. If the bird thus sighted by Puffy is a hawk or an eagle, he watches it until it is out of sight. If it proves to be a crow or a swift he gives it merely a glance and looks away. The barred owls frequently look at the sun with their eyes half-closed for fifteen or twenty minutes at a time. Why they do it I am wholly at a loss to explain. I am in doubt as to how much Puffy can see at night. I once held a cat within a few inches of him in the darkness, and he did not stir. Had he seen it he would certainly have moved and probably snapped his beak. In August, 1891, I let him out after dark on a patch of closely cropped grass where the dim light enabled me to see him when he moved. I went to the nearest tree and seated myself with my back against its trunk and my legs stretched out before me. Half an hour passed, Puffy scarcely moving except when a bat flew over him, and I keeping perfectly motionless. At last he came toward me, slowly, a yard or two at a time. When he was within a few feet I could see his outline quite plainly. One more hop brought him to my knee, upon which he jumped. Instantly he bounded into the air and made off, unmistakably frightened. He had no idea that he was going to strike a leg and not a log; yet if his eyes had been much keener than a man's he would have seen not only that my clothes were not wood, but that I was leaning against the tree-trunk watching him. In several instances I have called wild barred owls at night and have had them alight in tree-tops close above me. I could see them against the sky, but apparently they could not see me sitting among the brakes and bushes below them. Once with an owl thus above me I imitated the squeaking cry of a wounded bird. I wished I had not, for the owl's ghostly wings brushed past my face so closely that I fell back into the bushes, fearing that he would strike at me again.

The memory of my owls is noticeably good. Puffy and Fluffy, the two barred owls which I have had longest, remember their favorite perches from season to season, and resume their chosen roosts after months of absence. In one instance Fluffy, on his return to Cambridge after four months in the mountains, flew the length of the cellar, expecting to strike a perch which had been removed, and, failing to find it, fell to the floor. It is only necessary for me to bring a box-trap into the barn for Puffy to come to the front of his cage, eager to be given a chance to catch the chipmunk which past experience leads him to believe is in it. Similar eagerness is shown in winter, when I bring a paper parcel into the cellar, the owls knowing so well that it contains food that they will tear it open themselves if I do not open it for them. If the bundle is brought in without their knowledge and thrown at random upon the floor, they do not find it, and will leave it for days untouched. Puffy does not like going out in my boat. If he finds that I am taking him to the shore near it, he invariably jumps off his stick and tries to hide in the bushes. Snowdon knows a piece of cloth which I have used to throw over his head when I have wished to handle him, and the sight of it is enough to cause him to make strong efforts to escape from his cage. All three of the barred owls hide their surplus food, and remember where they keep it. Snowdon, on the contrary, sometimes stands over portions which he is not ready to devour, letting his feathers sink down so as to cover them. Puffy not only understands the commands "Get on" and "Get off," but he knows his own name, and generally answers when I call him by giving a friendly "clap, clap" with his beak. He has frequently revealed his position to me by this answer when I have lost him in the bushes, tall grass, or at twilight. That he especially, and all my other owls to a less degree, know me and distinguish me readily from strangers, is, I think, undoubtedly a fact. Thus far I have been unable to see that any of the owls have a clear notion of time, except as indicated by the coming or going of daylight. The digestive workings of owls are extremely economical. In summer the birds have enormous appetites, and become frantic with hunger if not fed every forty or fifty hours. In winter, on the contrary, the mature birds fast for a week or more without complaint. During the winter of 1889–'90 I could not ascertain that Fluffy ate anything for more than a month—that is, from Christmas-time until the first week in February. Throughout this period he seemed well, though inclined to keep quiet and to stay in the darkest corner of the cellar. When fed regularly and amply, all the species of owls with which I have had any experience cast from their mouths egg-shaped "pellets," composed of the bone and hair, fish-scales, and feathers which remain in their stomachs after the digestion of the more nutritious parts of recent meals. This ejection is accomplished easily and quickly, with very little visible muscular action. It usually, or at least often, takes place at the moment when the owl has another hearty meal in view. The owls' furnaces burn nearly all that goes into them. Considering the amount of fuel put in, the extremely small amount of ashes is wonderful.

In disposition my owls vary widely. The barred owls are—as owls go—remarkably sweet-tempered and gentle. I never have seen one offer violence to another, even when two were struggling over a morsel which both were determined to have. Snowdon is sullen, stupid, cowardly, and treacherous. The great-horned has a temper, but he generally keeps it concealed under an air of dignified reserve. My screech-owls, when not shamming sleep or death, were irritable, quarrelsome, and ferocious. Between my three-barred owls there are individual differences in disposition, which are readily learned but not easily described. They stand out distinctly in my mind as three characters, just as three children or three horses would be distinguished when I thought of them. I feel as much attachment for Puffy as I possibly could for an intelligent and faithful dog. His crippled wing has probably made him unusually docile and tractable, but, whatever may be the cause of his goodness, he certainly is a model of patience, placidity, and birdly virtue. This, in combination with pluck, which leads him to charge upon and vanquish dogs, cats, and domestic fowls, and a magnanimity which enabled him to roost for weeks alongside of an old hen, will make him worthy of owlish canonization when in good time he is gathered to his fathers.

ALMOND CULTURE IN CALIFORNIA.

By HENRY J. PHILPOTT.

DURING the fiscal year ending June 30, 1890, the American people imported 5,715,858 pounds of almonds, valued at $813,278. The value of all other nuts imported was $800,376. I confess my surprise at this fact, that we spend more money for almonds than for all other imported nuts put together. It would not be so surprising if this were the cheapest of our imported nuts. But, on the contrary, it is the highest priced, not only in the countries of exportation whence we draw our supplies, but still more so to the consumer in this country, on account of the higher import duty. The duty on almonds is five cents a pound if unshelled, and seven cents and a half if shelled. The highest duty on any other nut is three cents on filberts and walnuts.

The average import price of the almonds was fourteen cents and a quarter, and of the filberts and walnuts 5·7 cents. The almonds imported were almost exactly half shelled and half unshelled, which would make the duty average six cents and a quarter; and so, adding the duty to the import prices, the prices in this country, duty paid, were 20·5 cents for almonds and 8·7 cents for filberts and walnuts. Thus our preference for the almonds seems to be conclusively established, in spite of the fact that our imports by weight of filberts and walnuts were nearly double those of almonds.

The home production of all these nuts is still so small that we have no reliable statistics of it. California produces both almonds and walnuts, but in small patches only. The southern end of the State has a considerable walnut belt, but the almond orchards are widely scattered. The area suitable for almond culture is confined to small spots distributed over the whole length of the State. It is doubtful whether there is enough of it all told to supply the

American market. What there is of it, however, is rapidly filling up with the trees. Not more than half of those already set out are now in bearing. So it may not be many years before the California almond-grower will be able to depress a market which he can never hope to wholly supply, even with the burden of a high protective tax of five cents a pound heaped upon his foreign competitor.*

For the past year I have myself been an almond grower, in a small way, my total product being almost exactly one car-load. The purpose of this paper is to describe the processes by which the favorite nut of Americans is produced and made ready for their holiday tables.

To begin at the beginning, the almond is strictly a budded or grafted tree. A seedling apple, peach, cherry, or plum is sure to be good for something and marketable at a fair price, though it may be far below the grafted stock in quality and productiveness. The seedling almond may, like other seedlings, be an improvement, but it is very apt to be utterly worthless and unsalable, and may be deadly poison. It is as if its evolution were so recent that its type is not well set, and its tendency to atavism, or "breeding back" to older types, quite strong. This inclination to "sport" shows itself even in budded and grafted trees. All except the oldest trees on this ranch were planted and budded on the ranch, under the careful supervision of the owner. In selecting the buds and scions he not only paid strict attention to varieties, but took care to cut from none but the most prolific bearers of the best nuts among the tested trees of each variety. In spite of all his care, we have some interesting sports. There are trees that never bear at all; others bear worthless nuts. One yields a nearly perfect peach-pit inclosed in a nearly perfect almond drupe. And the four named varieties, though amply distinct when fairly represented, now and then shade into one another so gradually that the most experi-

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* The table on page 314, Internal Commerce of the United States, 1890, estimates the "shipment" of almonds as follows:

Year.	Pounds.
1885	1,050,000
1886	600,000
1887	500,000
1888	450,000
1889	600,000

Whence or whither the "shipments" were made is not stated. The connection indicates that they were from the eight leading fruit and nut shipping points in California. The figures look like guesses, and no clew is given to the amounts shipped from the other points to San Francisco, to be reshipped and thus counted twice in the table, which does not include some important almond-shipping points; and would not include my 15,000 pounds sent from a point not named in it direct to Chicago.

enced pickers have difficulty in deciding which box to empty their baskets into.

Of the many varieties of almonds four only are cultivated on this ranch, and their most important difference is in the weight and hardness of shell. None of them is a hard-shell, but the standard is a rather hard soft-shell; the Languedoc is the regular soft-shell, so quoted in the market reports; the paper-shell is the nut regularly quoted as "paper-shell"; and the California paper-shell is a new and very distinct variety which originated within a mile of here, and has made this ranch famous among the nurserymen of the State. The trees grown from its buds and scions probably number at this writing half a million. At any rate, enough has been cut from it to produce a far greater number. It was a purely accidental seedling, not a premeditated hybrid. But its good size, plump kernel, extraordinarily thin, light shells, sweet flavor, and agreeable appearance have won its way in the markets; and sold alongside of other nuts, hard-shell, soft-shell, or paper-shell, in San Francisco, New York, or Chicago, it brings the highest price of all by two or three cents a pound. It is the truest of all to type, and most distinct in the form of the tree. Mr. Morrison at first set out a twenty-five-acre orchard entirely of this variety. But, being disturbed by reports that it had proved a shy bearer, he sawed off three fourths of the trees and grafted in the better-known varieties. The new almond certainly has not borne so well as the others since I have been familiar with it, and I am afraid the difference in productiveness offsets the difference in price. Otherwise the California paper-shell would be a valuable contribution, strictly American, to the improvement of the almond; and Mr. Webster Treat, who has tried it on a larger scale than anybody else, claims in his paper, read before the State Board of Horticulture, that it is the hardiest and most prolific as well as the most salable almond grown. He confidently predicts that it will drive the foreign almond out of the market.

The almond is an unpruned apple tree in size and shape, and in smoothness and color of bark; a peach tree in foliage and green fruit. The leaf is so exactly like that of the peach, to which it is most nearly related, that the casual visitor can not distinguish them. The same is true of the fruit in a very green state. The drupe is a peach in taste and smell, both green and dry. The almond is quite commonly grafted on peach stock, though some prefer the almond stock on account of its alleged greater hardiness and longevity. An almond orchard in bloom is a thing of beauty. The first one I ever saw was the one immortalized in the story of Ramona, and it happened on Washington's birthday. The date shows what an early bloomer it is. First of all the fruit blossoms of spring comes the showy almond, a dense mass of white with a "hint of a tint" of pink in it.*

The cultivation of the almond is easier than of any other tree, unless it be the prune. The orchard is plowed and harrowed once or twice a year, and then the weeds are kept down in any way the farmer chooses. The amount of work required to do this depends on the weather, and is just the same for the almond as for any other tree. But the almond tree, like the prune, is never pruned in this region. Like the prune, the fruit is never thinned on the tree, as the peach and apricot must always be, to produce a crop of good fruit. The heavy pruning and thinning required every year on our peach and apricot trees is a great expense, the thinning alone often costing fifty cents a tree, for an average of the whole orchard. Aside from stirring the soil and killing the weeds, a dozen apricot trees take more care and labor than a dozen acres of almonds. This is the consideration that makes almond-growing popular. Equally important is the fact that thus far the almond has no parasites, such as scales, moths, etc., while almost every year adds a new recruit to the insect enemies of other fruits. Our peach-growers are put to the expense of buying costly machines for spraying their trees, and insecticides with which to spray them. Insecticides cost money, and spraying costs time and labor. If the wash is strong enough to kill the scale, it is apt to kill the new wood of the tree—a very serious matter in the case of the peach, whose fruit is all on its last year's growth of wood. Still, the spraying must be done every year, and may even be enforced by law in California. All this trouble and expense are saved to the almond-grower, whose only insect enemy is the red spider, a semi-occasional visitor easily got rid of, and not formidable if left unhindered in his work.

First to bloom in the spring, the almond is last to mature in the fall. The whole spring and summer long it hangs there, a green peach for all the world, and after the first few weeks never increasing in size or changing in appearance. The seam is deeper than in most peaches, but not deeper than in the ripe apricot. Late in August this seam will be seen to have opened in a few of the earliest. The grower's anxiety now reaches its climax. Will his almonds open and remain open until harvested, or will the drupe remain closed, or only partially open and then close tight again? The whole profit of the crop may depend on this question. It may cost half they are worth to pick and husk them.

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* The writer in the Encyclopædia Britannica combats the ancient tradition that almond blossoms are white. He says they are pink. As I have seen them it is more proper to call them white than pink, though the whitest contain a suggestion of pink, and some varieties show it so plainly as to be distinguishable at considerable distances.

Just that thing happened this year to my nearest neighbor, and to several neighbors; while the nuts on this ranch opened better and husked easier than ever before in the whole course of its thirty years of almond-growing. The result was, that our pickers earned a dollar and a half a day picking at half the cost per pound incurred by our neighbors, whose men earned a dollar and a quarter a day.

The nuts are knocked off the trees with long poles. Where they have opened nicely they are allowed to drop on the bare ground, and are husked as they are picked up. The picker's delight, if he is working by the bushel or box, is to see the ground covered with nuts that the stroke of the pole and the impact against the clods have completely husked, so that he has nothing to do but throw them into his basket. He is lucky indeed if half of them come out that way. Those that do not are husked with the fingers. The new paper-shell above described is one of the freest, and its drupe often falls off spontaneously before the picking season, leaving the naked nut hanging to the tree. But the nut so free from its drupe clings tightest of all to its tree, and is often quite hard to knock down without injury to the branches. Otherwise the saving in its harvest expense would be quite an important point in its favor.

In the best of seasons there will be a large part of the crop so badly opened as to require a different process. A canvas is spread under the tree for the nuts to fall on. When all are knocked down, the canvas is rolled up and with its load of nuts carried to any spot near by where it is convenient to heap together the harvest of several trees. A simple table of loose boards is made, and around it gather the pickers. One of the party rubs the nuts to loosen the drupes, and the others husk. The rubber is an extremely simple machine, exactly like a washing machine in principle. Practically it is two old-fashioned wash-boards rubbed together. In appearance it is a flat-bottomed pig-trough, six or eight feet long and open at one end. Across the bottom inside, pieces of lath are tacked an inch apart, and thus the lower wash-board is formed. The nuts are scooped into it, a few pounds at a time, and a shorter board, likewise ribbed crosswise with lath, handled like a flatiron or a plasterer's trowel, is rubbed over them by hand, loosening their husks and pushing them along to the open end of the trough, where they fall into a box and are heaped on the table, to be now easily husked. It is a cheerful thing to see the assembled pickers seated under the shade of a tree, making their fingers fly and heaping up their boxes with the precious harvest. The damper on the meeting is the fact that almost invariably the pickers are Chinamen. Their gay chatter might as well be that of monkeys, for all the sense you get of it.

At many kinds of work white men are more profitable to employ than Chinamen, though they demand much higher wages. At picking almonds the Chinaman is preferable at the same wages. Fewer nuts escape his keen eye to be left on the tree or under the clods. He can pick more in a day, and with less damage to the tree and the nuts.

In large orchards a more complicated but still crude and unsatisfactory rubber is sometimes operated by horse or steam power. But the nuts and drupes must still be separated by hand, and probably always will be. The drupes are mostly only loosened by the machine, many of them not even that, and but few of them entirely rubbed off. This last might be done by machinery in the case of quite hard-shelled nuts. But more force is required to remove the drupe than to break the shell of a large portion of the crop. In some orchards every year, and in many orchards this year, the only way to market the almond was to crack it with the drupe on and sell the kernel. Others who did not deliberately crack were obliged to rub so hard that many of the kernels came out, and at the close of the harvest they had barrels of them to sell as shelled almonds. The price per pound is greater than of unshelled almonds, but my neighbors say that the addition to the price does not make up for the weight of shells thrown away, to say nothing of the extra labor and expense of cracking.

Where the picking was done by hand, and paid for by the box, it cost this year, in this vicinity, seventy to ninety cents a box. The box used is what is called the large-sized free apple-box. That is, it is the box which holds an honest bushel, and goes with the apples when they are sold in the market. The first boxes I got from the factory were free apple-boxes, and I supposed that was all right and sufficient, until the Chinese foreman of our band of pickers brought out the box he had used in former years, and I saw that mine were smaller—just enough smaller not to arouse suspicion in the breast of the final consumer when he buys apples by the box, and at the same time to save the middle-man, who buys by the pound and sells by the box, a few pounds in each box he sells. He prefers that the producer should ship his fruit in these dishonest boxes, just as the San Francisco butter dealers, who buy by the pound and sell by the roll, caution the farmers not to put quite two pounds in a roll. So I found that my apple-boxes were short-weight boxes, and were losing me the cost of picking about three pounds out of every box of almonds picked; and that this loss would in one season cover, several times over, the price of the boxes. I put this part of the story in for whatever it may be scientifically worth, as a contribution to the study of commercial ethics. I bought the larger-sized bushel boxes as quickly as possible. It cost me one dollar and fifty-six cents to find out the difference between a bushel of apples and a bushel of apples.

Picking and husking the almonds cost us exactly fifty dollars a ton, and our neighbors all the way up to twice that. Outside of my own family we employed a varying number of Chinamen, up to nine. The task lasted from the 18th of September to the 28th of October. The boxes picked each day are gathered in the evening and conveyed to the drying-yard, where the nuts are sun-dried for a few days. Then comes the bleaching, which is done with the fumes of sulphur, and requires care and some experience.

The bleaching-box is built in various fashions, but covered with tongued and grooved boards and in other ways made tight, so as to confine the sulphur-smoke as much as possible. In common orchards it is about six feet square and six or seven high. It is a complete inverted box, and often movable. The drying-trays are slid in on cleats like the draws of a cabinet. Almonds, being dried before they are bleached, are sprinkled or sprayed with clean water just before sulphuring, the moisture being necessary to make the sulphur do its work of bleaching. The proper quantity of sulphur for one bleaching is put into a pan, ignited, and set inside the bleaching-box. The doors are closed tightly, and left so until the sulphur is all burned. The almonds are then taken out and dried again for a few hours, to remove the moisture sprayed upon them before bleaching.

If they come out bright and evenly bleached, the grower's heart beats more quickly. He knows that it is the color that sells his almonds. Consumers may growl as much as they please, and preach on the sin of poisoning their fruit with sulphur-fumes, but they will always buy the poisoned (?) fruit and give a much higher price for it. They may pat the honest grower of unbleached fruit on the back, but trust them never to give him a penny's worth of encouragement in the market. To-day my paper quotes unbleached apricots at two to four cents a pound, and those that are bleached, or "sulphur-poisoned," at five to six and a half cents. All these prices preclude living profits. Who knows how many growers of unbleached fruit this year's ruinous prices will drive off their farms and out of business, to make room for a like number of sulphur-poisoners? And, going back to the apple merchants and butter dealers, we must admit the full force of the same apology for their crookedness.

But aside from the fact that the fruit-grower is held, much against his inclination, by his final consumers to *his* questionable trick of trade, the question is still open whether it really does them any harm. Sulphuric acid, like many poisons, is a medicine in proper doses. Does a tablespoonful or two of well-bleached peaches, taken at meal-time, contain a poisonous or a medicinal dose of the acid? Remember, they are not sulphured *ad lib.* The consumer and the middle-man set the bounds. A distinctly susceptible sulphur taste hurts the peach in the market, and reacts on the grower. He is obliged to learn the art of securing a thorough bleach without the sulphur taste. To do this he must have the right kind of sulphur, and a very tight bleaching-box properly arranged inside; and he must know how much sulphur to put in, and how long to leave his fruit exposed to its fumes. The most experienced of my neighbors still differ widely on all these details. But I am convinced that, with proper facilities and proper skill and care, the bleaching may be made to entirely satisfy the eye of the consumer without injuring the rest of his body. I confess I should like to be still better satisfied on the point. But I console myself with the reflection that sulphur-smoke is a famous disinfectant, and must render the fruit-eater less liable to all those diseases originating in germs, either microscopic or otherwise. Who knows but that a thorough scientific investigation, bacteriological as well as chemical, would prove the sulphur-poisoner to be, on the contrary, a conservator of the public health?

But whatever guilt the fumes of sulphur fasten upon the fruit-grower, the almond-grower is clear of; for he does not sulphur his fruit at all. What he sulphurs is but the shell that is thrown away—that is, if he does his work properly. If he sulphurs while the nuts are green, or wets them too much just before sulphuring, the fumes may penetrate to the kernel; especially of very soft-shelled or paper-shelled almonds. But he gains nothing by it, not even in the appearance of his nuts, and does it from ignorance or inexperience rather than from policy. I tried this thoroughly, and by watching closely the result of each experiment was able to improve on the best advice my neighbors, old in the business, could give me. First, our old bleacher being too open, a new one was built. Then the almonds were made a little drier than they need be to go to market. Then the water was put on in the finest spray attainable, so that the nut was slightly but evenly dampened, but little if any more than enough to make up for the overdrying. Then the time of exposure to the fumes was regulated, not by the watch, but by the quantity of sulphur put into the pan, so that, whether we bleached in the daytime and took out one bleacherful to make room for another, or went to bed at night leaving the bleacher loaded and the sulphur burning, the nuts always got the same dose and no more. We kept on until we found the minimum of moisture and the minimum of sulphur that would do the business.

The nuts came out of the bleacher looking beautifully, all the more so by being laid out in the drying-yard in rows or squares alongside of the black, ugly things not yet bleached. They never look so pretty afterward, for the sunlight required to dry off the moisture artificially put on blackens them to a certain extent. Here we got the advantage of not moistening too much. Our overdried nuts absorbed part of this moisture, and they could soon be removed from the discoloring influence of sunlight, and the curing finished in the shade. Manipulated in this way, the kernel of the finest paper-shell can not be hurt by the sulphur.

And this leads us to the observation that, as a rule, the harder the shell, the whiter the almond bleaches. This rule does not hold always and absolutely, for, while no paper-shell approaches the mere soft-shell in whiteness, the whitest of our paper-shells is also the softest-shelled—namely, the new "California." But while the market pays more for the darkest paper-shell than for the whitest soft-shell, the tourists who visit our yards are always most attracted by the "Standard," the hardest of our soft-shells, because of its showy whiteness. In the market it brings about two thirds the price of our black, old-fashioned paper-shell—that is, in the San Francisco market. But just here I had one of my most interesting experiences in almond-growing. I sent fair samples of each of our four varieties to San Francisco and also to Chicago. I was struck by the grotesque difference in the relative prices quoted from these samples. Thus, in cents per pound:

Variety.	San Francisco.	Chicago.
California paper-shell	14	18
Common paper-shell	12½	12
Languedoc	10½	15
Standard	9	15

The tawny skin of the common paper-shell, easily cracked by twisting in the fingers and yielding a large weight of kernel in proportion to weight of shell, was too much for Chicago, and it was quoted away below the heavy-shelled, hard-shelled Standard, requiring the use of the hammer, or the clumsy nut-cracker, and its weight consisting largely of waste shell.

If any of these varieties had a kernel suitable for the confectioner or the baker, and he bought them unshelled, he could afford to pay considerably more for the paper-shells; for he would be paying for little else but kernels, and these would be easily extracted. However, the kernel used in candies and cakes is that of the imported Jordan almond, in San Francisco as invariably as in Chicago or New York. It is imported shelled, and is longer and smoother than anything we have yet produced. It comes from Malaga. Those who buy nuts by the pound for the table, or to carry in the pocket, would save money by paying a little more for paper-shells, to say nothing of convenience in cracking—especially as a pocket nut. Those who buy them for children inclined to use their teeth as nut-crackers would save something worth more than money. The child who disobeys and clandestinely cracked his almonds that way would not be damaging his teeth as much as if chewing a hard crust of bread or a dry toast. On the other hand, many persons, after their attention has been called to the subject, like, or think they like, the flavor of the harder-shelled Standards and Languedocs better than of the paper-shells; and *de gustibus non est disputandum.* The writer hereof has no preference. He never did eat almonds, nor any other imported nuts except Brazil-nuts, when he could get the native nuts of the Mississippi Valley.

If this is due to early associations, the almond would by the same token be the favorite nut of the younger generation of California almond-growers. They had no eatable wild nuts, their native walnut tree, transplanted to their homes for its beauty, bearing a worthless nut. The almond, of all their crops, was best adapted to cultivate and felicitate home life. They harvested it themselves, knocking the nuts off the tree in the daytime, husking what they could, and carrying the rest into the house to be husked by all the nimble fingers of the large, old-fashioned families at night. Prices were high then, and every pound husked meant twenty, twenty-five, or even thirty cents. With such prices, never-failing crops, and little or no cash expense, it is no wonder that almond-growing became popular, nor that the solidest farmers attribute their present comfortable circumstances to almonds. Well may they turn from these degenerate dime-a-pound seasons of more than occasional failure, when the inevitable Chinaman, whom the Exclusion Act has exalted into a grasping monopolist of labor, takes half the proceeds of the harvest, and takes it before the producer gets the first penny of it into his own fingers, back to those cheery days of old.

Cured ready for market, the nuts are stored or shipped just like barley, the same coarse gunny-sack being used. Its capacity is that of the cotton sacks used by Eastern farmers, by them branded and kept on the farm. The California sack is also often branded, but goes all the way to the final market and never comes back. All grain is shipped from Pacific ports in that manner. And, though the single sack costs but seven to ten cents, the whole expense is a great burden—estimated for the State at $2,000,000 a year—on the California producer. He can not escape it, for there are no elevators. Where grain has to be handled from five to ten times before reaching its consumer, the sack becomes a still more expensive crudity, shaving down the producer's profits. To the grain-grower the average loss by it is officially estimated at ten per cent of his gross proceeds. The sacks alone cost me six per cent this year on the gross proceeds of a thousand bushels of the best brewing barley, sold at a price twenty-five per cent higher than that realized by the average grower of the common grades. How much I paid the warehouseman at home, the one in San Francisco, the one in Liverpool, and the brewer, each of whom handled it twice, for the extra work of the sack system over the elevator system, I do not know. They may have done it gratis, but I do not think so. At any rate, long after the system is universally recognized to be a monstrous and unnecessary burden, we shall be held to it by the same cause which binds England to its crude passenger-coach and America to its deadly hand-coupling and brake on its freight trains—the necessity of changing all at once and on so large a scale when the change is made.

But the burden on the almond-grower is trifling—one per cent for sacks in my case—the product being so much more valuable in proportion to bulk. The sack is altogether an advantage. It saves the delicate shell, and furnishes a place for the brand of the orchardist who is proud of his product and wishes to work up a reputation for it, and also for another brand giving the name of the variety contained in each sack.

An important practical question confronting every prospective orchardist is, How soon will my trees come into bearing and pay their own expenses and interest on my investment? In these days of harnessed steam and chained lightning, young America plants for himself and not for his children. Some old men who have tried it a little have come to the conclusion that too much planting for posterity is a mistaken kindness for which posterity, lying in the shade, kicking up its heels and letting its faculties rust for want of planting to do, returns no thanks. The almond is an early bearer. At four years from the seed the orchard of which I am the lessee yielded, at about average prices, about eighty dollars per acre gross—say sixty dollars net. This year at six years old, prices considerably below the average, the gross proceeds will be about one hundred and twenty-five dollars per acre. I do not think any other orchard yielded so much per tree, of the same size; but, on the other hand, these trees are so wide apart (twenty-eight feet) that there are only about half the usual number of trees on an acre. While the trees are small, this tells against the yield per acre, and so in this respect this orchard is probably only a fair example. It was not an exceptionally early bearer. In a general way it may be said that an almond orchard yields as quick returns as an average herd of beef steers, but not as quick as a herd of heifers. And in the mean time the planter does not lose the use of his land. He plants other crops between the rows and does not lose a single year. But of course no ordinary annual crop can yield a profitable return on the price he will have to pay for land known to be adapted to almonds.

The almond, most precious by weight of all orchard products, involves the least labor, care, anxiety, expense, and skill of all, except perhaps the prune. In recent years it has never yielded the fabulous returns occasionally realized by the growers of almost every other fruit and nut. It never yields, as the orange has, a competence for life in a single year from ten acres. Its reasonable expectations are about one hundred dollars net per acre.

The old Latin form of the word almond (*Amygdala*) furnishes the name whereby botanists designate the genus to which belong its two species (*A. communis*, the sweet, and *A. amara*, the bitter almond), and the peach (*A. persica*).

LEATHER-MAKING.

By GEORGE A. RICH.

XV. DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

ZADOCK PRATT, the great leather manufacturer, once gave as his toast at a notable trade dinner, "There is nothing like leather." The determined, enterprising spirit indicated by that sentiment may be said to be the distinguishing mark of the modern tanner, and it is possible that therein lies the explanation why one in tracing the course of that industry must look so largely to recent years for progress and development. But the course of this development furnishes an interesting commentary upon the application, or more accurately, perhaps, the lack of application, of the principles of science to this one of the industrial arts. Now, the art of tanning is one in which a knowledge of science, especially of chemical science, could be made to do most effective service. The operation is essentially a chemical one. Yet, as a matter of fact, since the first demonstration of the union of gelatin and tannin, chemistry has done almost nothing to facilitate the operation. It is not to that that the industry owes its remarkable progress; rather, it is to the invention of improved apparatus for hastening old processes. Just estimate, of course, must be made of the fact that the scientific knowledge of the principles involved in tanning did much to make these inventions possible. At the same time, however, as Mr. C. T. Davis has remarked in his admirable treatise upon leather: "Take away our bark and hide mills, improved leaches and vats, handling and stuffing appliances, and other improved constructions; our splitting, scouring, boarding, whitening, polishing, pebbling, and other modern mechanical inventions, and our steam-power so economically derived from the use of spent tan as fuel: turn us out of doors to work among the rude contrivances of a century past, and would the result of our labor show an extraordinary gain either in time or quality over that of our predecessors?" Any review of this development, therefore, though it is a record of splendid achievements, is not one of the discovery or introduc-

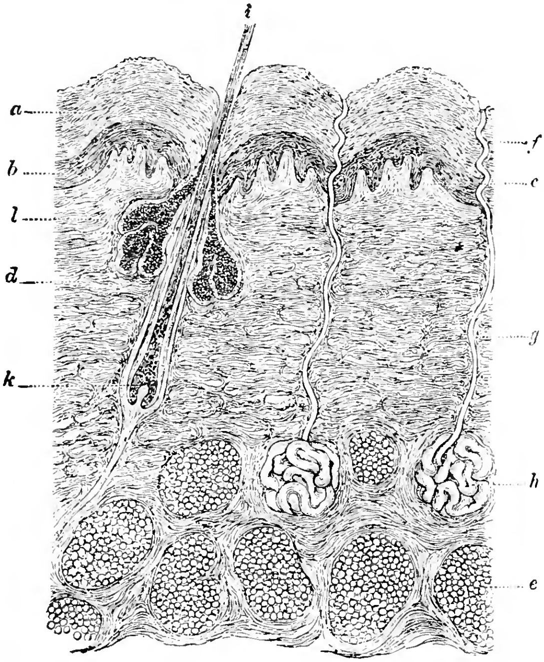

Fig. 1.—Section of Animal Skin (magnified). *a*, epidermis; *b*, dermis; *c*, corium, or base of the skin; *d*, fibrous tissue; *e*, fat-cells; *f* and *g*, ducts of the sweat-gland; *h*, sweat-glands; *i*, hair; *k*, hair-bulb; *l*, sebaceous gland.

tion of new principles. It is a record of mechanical improvements and business economy.

Unfortunately, history gives us little definite information regarding the origin of this one of the industrial arts. Surmises, however, go for considerable in this case. The skins of birds and animals formed a large part of the first clothing of man. Now these would be found to grow hard and horny in their natural state, and on exposure to moisture to become putrid and offensive. Efforts to counteract this, and at the same time to render the skins soft and pliable for use, would be most natural, and to these are traced the beginning of the leather industry—an industry which in its inception can properly bear no wider designation than the "dressing of skins."

Leather, in the broad application of the term, is a combination of gelatin and mineral salts, oil or tannic acid. The hide or skin of an animal consists of two layers—the outer (epidermis), a hard cellular plate into which neither nerves nor blood-vessels penetrate; and the inner, or true skin (dermis), a dense membrane composed of fibers interlacing in a curiously complex manner. These connecting fibers consist almost wholly of gelatigenous tissues. They will dissolve in boiling water, thus forming gelatin, will enter into solution with concentrated acids and alkalies, and will combine with oil and tannin. As such this tissue forms the basis of all leather, and the labor of the tanner becomes one of bringing it into chemical or mechanical combination with these other components.

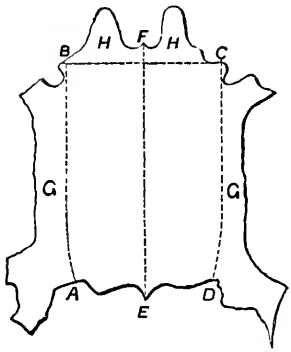

Fig. 2.—Divisions of a Hide. A B C D is termed the "butt," and the halves of the butt marked by the dividing line E F are known as "bends." H H are the "cheeks," while the upper portion of the butt figures as the "shoulders."

The original process of curing skins was probably the simple one of cleaning and drying them. Removal of the hair by maceration in water seems to have been common among the very early tribes, and one writer has suggested that the idea was obtained from the natural process of depilation. They must certainly have been familiar with it in the case of drowned animals, where maceration can be plainly observed. Following this, smoke, sour milk, oil, and the brains of the animals themselves were found efficacious. Many of these primitive methods are employed at the present time, thus bringing into novel conjunction the days of the roving Massagetæ and those of the thrifty American. An acquaintance of the writer, a Massachusetts tanner, traveling recently through the province of Winnipeg, chanced upon a small Indian village. The place was in no way interesting except in the employment of the squaws. They were all busily engaged in removing the hair and muscles from the skins, largely those of deer and moose, which the bucks had taken in the chase. This they did by means of sharpened bones which they plied in a vigorous manner, rubbing away both flesh and hair. The skins, it seemed, had been taken from the animals some time before, and together with the brains partially dried in the sun. After the squaws had completed this scraping process, the skins were steeped in a lather-like mixture made from water and dried brains, and were then reduced to a soft texture by frequent knead ing and similar manipulation. Ten days later this same manufacturer was in Peabody, Mass., in one of the most complete of modern tanneries, and, though the space of time intervening was only a little more than a week, yet in it he had traversed the whole gamut of the art.

In order of development after these crude methods came the discovery that certain astringent barks and vegetable substances possessed the property of condensing and arresting the septic tendency of animal membranes. This discovery must have been made very early, however, as the knowledge of it appears among many of the ancient nations. But, whatever the time, from it dates the beginning of the tannery. The Egyptians were probably among the first to become proficient in this process of preparing what had come to be such an important article of personal economy. Among the tapestries and sculptures that remain to us from them are several which picture the operations of currying, working, and stretching leather. One in viewing them might almost imagine himself in a small country tannery. Figures are seen using the familiar awl, polishing-stone, and the semicircular currier's knife, while the processes depicted are very suggestive of the present day. But the Egyptians are by no means to be given all the credit for this progress. They undoubtedly obtained many of their most valuable suggestions from the Arabs. Those roving Bedouins were by no means botanists in the modern sense of the word, but they had a thorough knowledge of all the peculiarities of such plants and shrubs as marked the desert, one of the most common of which was the acacia. That this knowledge was a practical one is proved by the fact that they were acquainted with the tanning properties of the pods of this plant. They were experts, too, in the methods of depilation, so that the Egyptians, by making a short excursion, had at

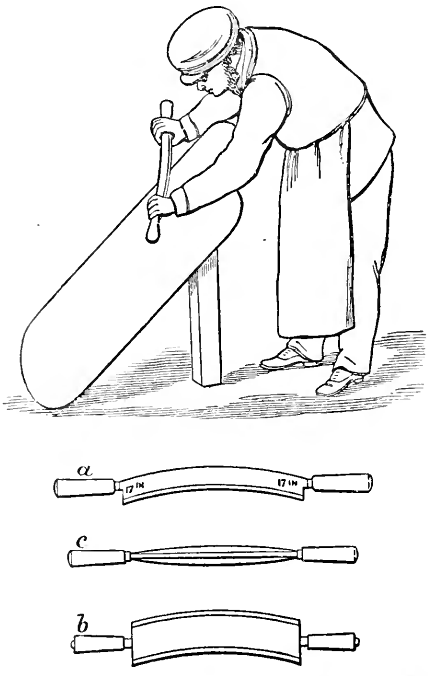

Fig. 3.—Tanner's Beam and Knives. The hide was thrown over this beam after the hair had been loosened, and with the working-knives (*a* and *c*) and the fleshing-knife (*b*) was scraped free of both hair and refuse. Machinery has very largely superseded these now.

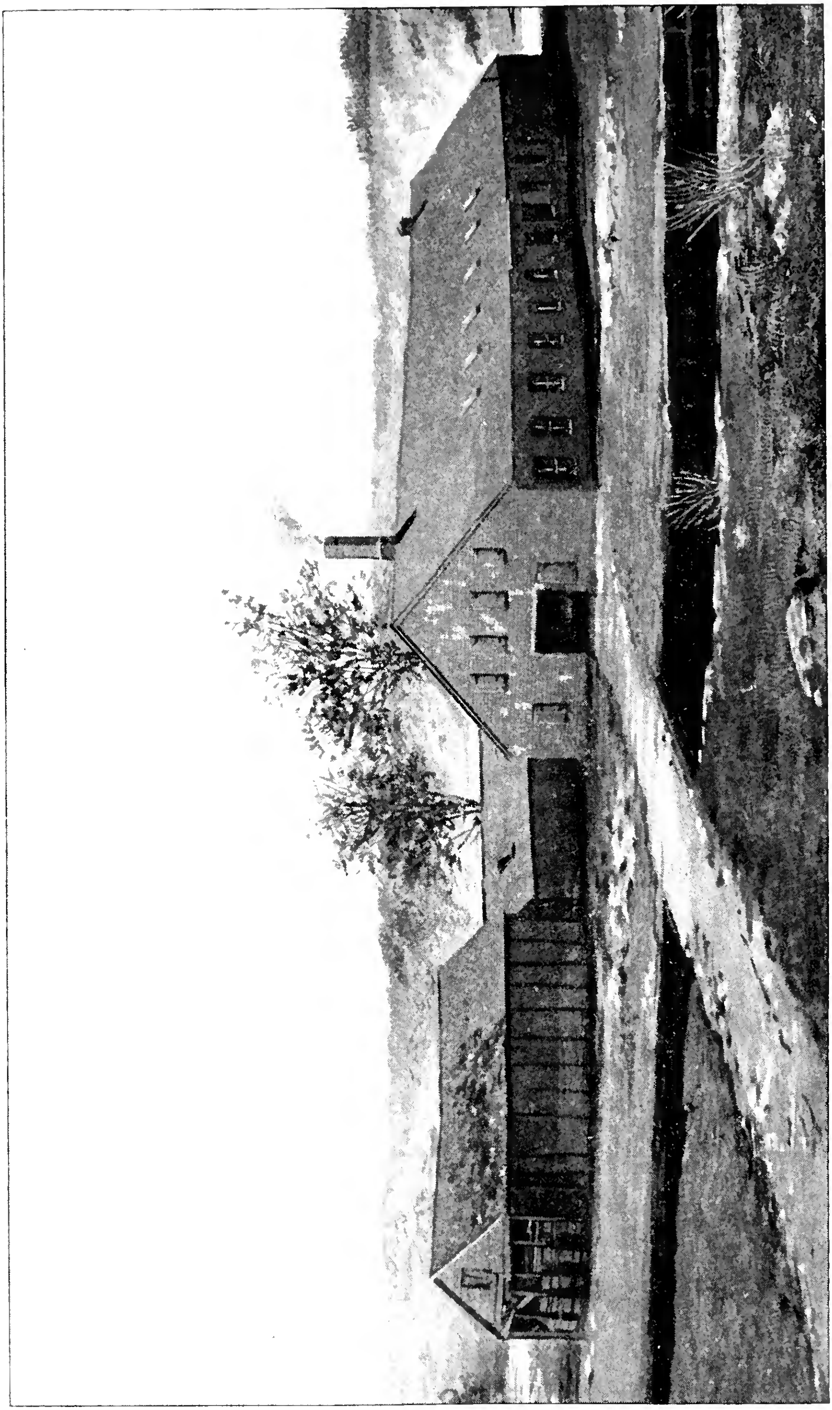

Fig. 4.—Old Putnam Tannery in Salem, Mass.

hand a considerable foundation upon which to begin the development of their art. But, once known, its extension could not be hindered. Herodotus states that the Libyans wore leather clothing, and that the Phœnicians, whose home was a barren stretch of shore, depended largely upon it in the construction of their

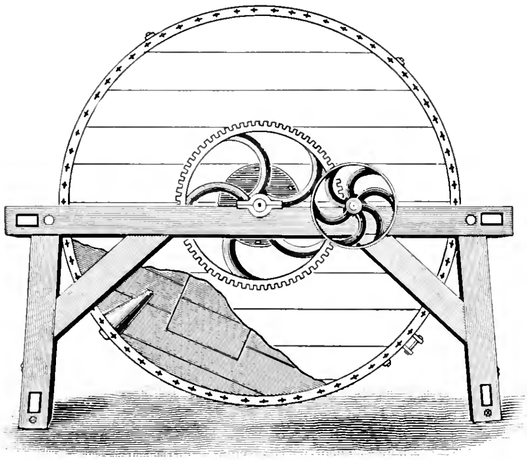

Fig. 5.—Dash-wheel.

ships. Persian and Babylonian leather was long celebrated, and as early as the beginning of the Christian era the Russians were famous as skilled tanners. Hungary, too, acquired an early name for its leather, having learned a peculiar process for making it from Senegal. Boucher carried the art into France; while Colbert, the enthusiastic patron of all the industries, did all that he could in the way of personal and public effort to extend it. Thus it was that leather became more and more an article of general use, and thus it was that by the time Columbus started on his hazardous voyages there had already grown up a considerable industry in England, France, Spain, Germany, and Russia.

But despite all this growth the processes involved in the operation of tanning were not really understood until the close of the eighteenth century, when they became objects of scientific study. Before that time the art was purely an empirical one. The immediate successors of Columbus brought with them to America such crude knowledge of it as was current at the time. Leather being a prime necessity, tanneries were started soon after the settlement of each community, either by the men of that craft or by the large farmers for their own convenience. Leather formed at that time no small part of people's clothing; indeed, leather breeches appeared clear into the eighteenth century, though the wearing of them was largely confined to servants and laborers.

It figured in nearly all the arts. It was used for harnesses and saddles. It was fashioned into boxes and articles of ornament. It served both as a protection and defense. Nevertheless, but little progress could be made until the settlers had obtained a stock of domestic cattle. Columbus is said to have brought the first of these animals to America on his second voyage thither in 1493. By 1610 they had been introduced into Virginia, while Plymouth and the New Netherlands received a supply a few years later. Tanneries then were started North and South. In a list of tradesmen to be sent to Virginia in 1620 are enumerated tanners, leather-workers, and shoe-workers. In 1649 Captain Matthews, an active

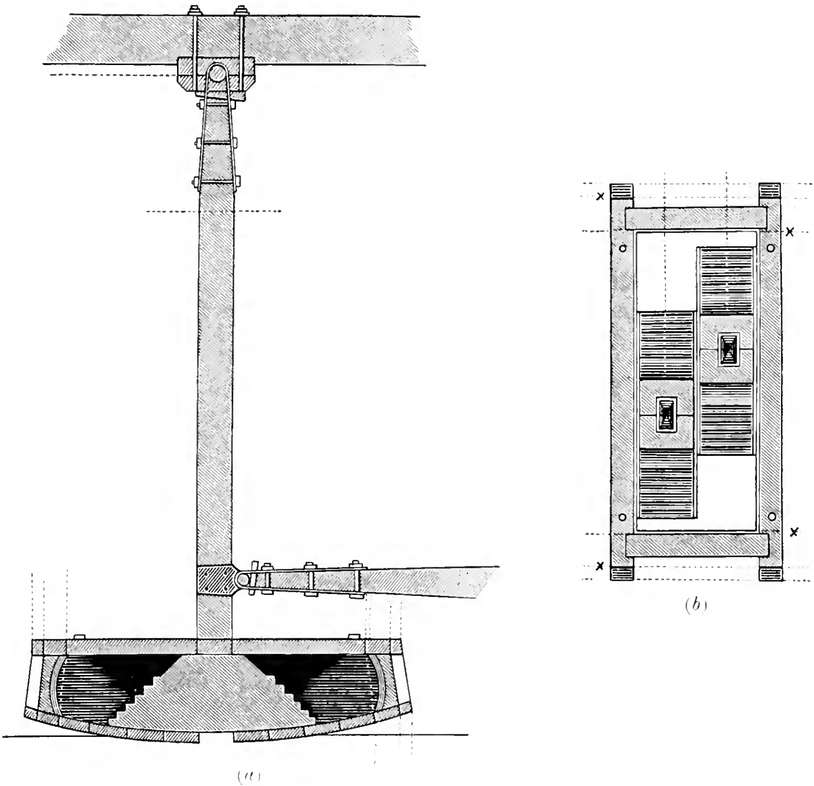

FIG. 6.—HIDE-MILL. The above figures (a and b) represent a working plan of the "Shover" hide-mill, or ordinary "fulling" stocks for softening hides. It is essentially the same as the apparatus used for fulling cloth, and is undoubtedly the forerunner of the modern washing machine.

figure in Virginian history, received legislative commendation for his enterprise in the building of a tan-house, the manufacture of leather, and the employment of eight shoe-workers. The Virginia Assembly, however, a dozen years afterward had to come to the rescue of the industry, passing a law which required that tan-houses should be built in every county at the county charge, and that provision should be made for the employment of tanners and curriers. The rates of hides and shoes were fixed, and stringent efforts were made to prevent the exportation of hides. Maryland adopted similar measures; but Beverly, writing a few years later, says of these enterprises that "a few hides were with much ado tanned and made into servants' shoes, but at so careless a rate that planters don't care to try them if they can get others."

Fortunately, the industry fared better in its first planting in New England, and Higginson probably struck the secret of this good fortune when, in 1630, he called attention to the extraordinary increase of cattle in Massachusetts, and the "store of sumacke trees, good for dyeing and tanning leather." Cattle continued to multiply rapidly from 1630 to 1650, but the prices placed upon them were so high that few were slaughtered. But in the latter year the cessation of immigration from Europe caused a depression in the cattle market, and they began to be killed freely, thus supplying the tanners with the necessary hides. The Massachusetts General Court, in 1640, recognized the importance of the industry, and passed a law punishing those who slaughtered cattle and neglected to save the hides and have them tanned. But Connecticut, Massachusetts, and Rhode Island thought that they must take a stronger hand in the pushing of this industry—those were in truth the days of infant industries, and of detailed trade regulations—and so special laws were passed for that purpose. Protection, in the current political sense of the word, was not known then, but the same ends were attained through the guild privileges. The general law of Massachusetts, passed in 1642, is typical of these regulations. This declared that no leather overlimed or insufficiently tanned, or not thoroughly dried after tanning, should be exposed for sale. Tanners putting leather into hot or warm "moors," where the leather should heat and burn, were to forfeit twenty pounds for each offense. Curriers were not to dress any leather imperfectly tanned or dried, nor use "any deceitful or subtle mixture, thing, way or means to corrupt or hurt the leather, nor curry any sole leather with anything but with good, hard tallow, nor with less than the leather would receive; nor dress or curry any upper leather but with good and sufficient stuff, not salt, and should thoroughly liquor it until it would receive no more; they were not to burn or scald any leather in the currying, on forfeiture for every one marred by unworkmanlike handling, to be judged by the oath of sufficient witnesses."

This law, probably, was of little value to the industry, as some years later it was repealed, and all efforts to enact similar measures proved fruitless. It throws an interesting light, however, upon some of the methods and practices then in vogue, as it was

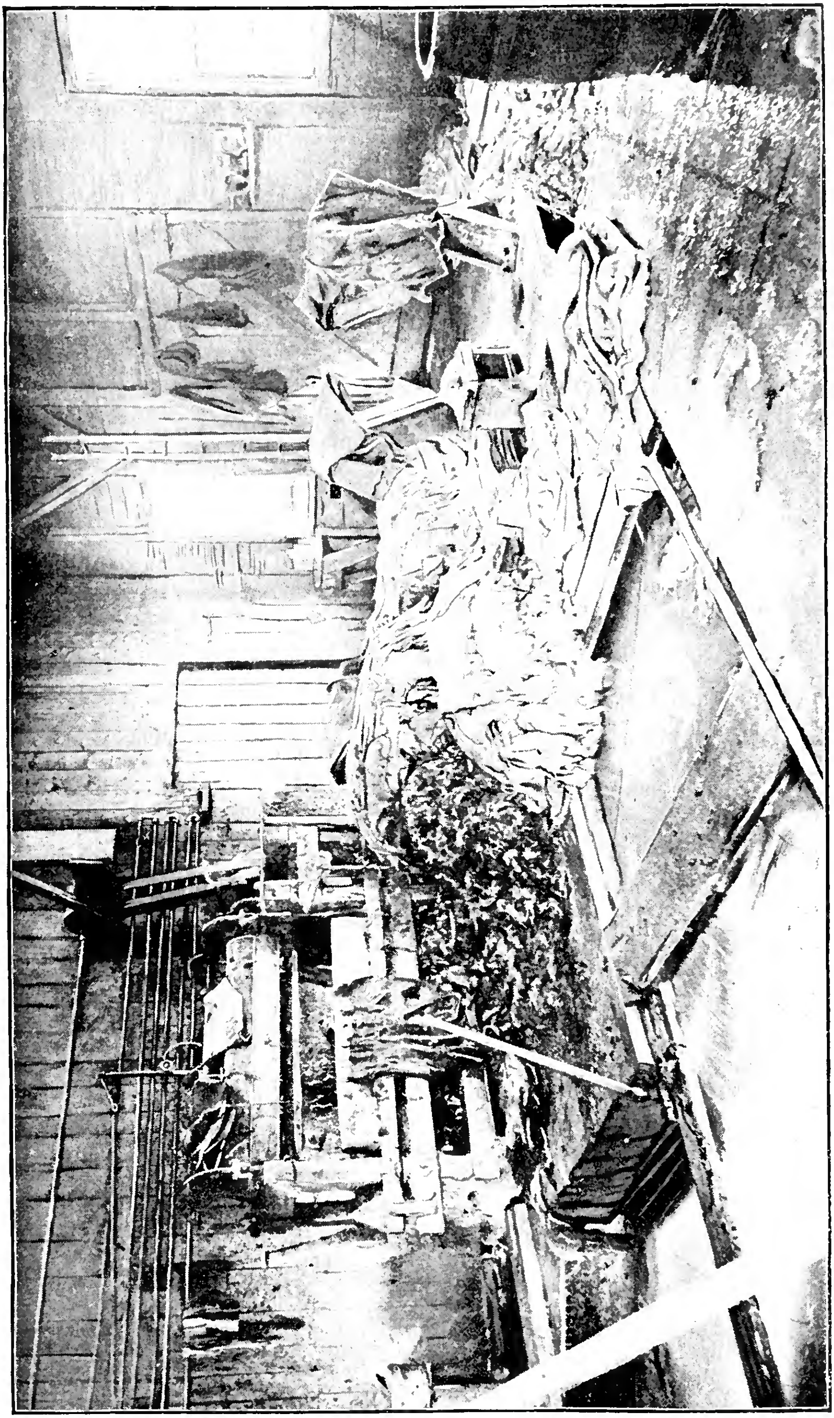

Fig. 7.—Corner in a Beam House.

stated that these laws were passed in consideration "of the damage or injury which many sustained by the ill-curing of leather, and by the shoemakers in making it up into shoes and boots." Thus left to shift for itself, the industry steadily though slowly progressed with the country until 1860, when new inventions and improvements in processes, and energetic men at the head of it, gave it a decided impetus which has constantly gained in force since.

As has been said, the fundamental processes of tanning have changed very little since the early days. The hides, as they came

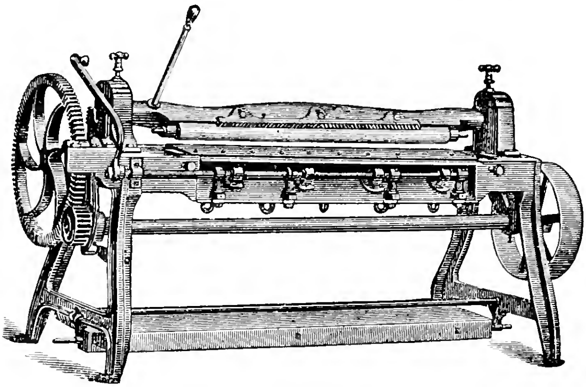

Fig. 8.—Union Splitting Machine.

to the tanner, were first washed, and then, in order to remove the hair, soaked in vats of water and lime or ashes. After having been thus unhaired, they were put over a beam and scraped until every remnant of flesh had been removed. After another washing they were "laid away"—that is, packed in vats in alternate layers of ground hemlock or oak bark. The object of this was to bring about the desired union of the gelatin and tannin. The operation, however, was a slow one, and oftentimes many months were required to complete it. But study, of course, has been since given to the details of these various steps, which has resulted in a marked saving of time. In the preliminary process of depilation there are two methods which are now commonly followed by American tanners. The first is known as the "liming," which is used largely in the preparation of upper leather; and the second, known as "sweating," which is used for sole leather. In the "liming" process the hides are soaked in a solution of lime and water, as indicated above, until the hair-bulbs are loosened. In sweating there are two methods also: the warm sweat, with the temperature of the pit at 100°; and the cold sweat, with it at 50° or 60°. The former method is in general use in southern Europe, while the latter is not only American in origin, but is the favorite one with tanners on this side of the water. Again, the process of depilation is still further hastened by the use of a mineral acid, like sulphuric, or by the handling of the hides in the old sour liquors where the tannic acid has become largely converted into gallic acid. There are strong advocates of both cold sweating and warm sweating, and of acid and non-acid methods, but there are no data on which pre-eminence can be assigned to any one of them. All have played an important part in abbreviating the tanner's work. Following depilation the hides are colored or passed through a series of vats containing liquors of varying strengths, and then laid away. Here, also, it is a matter of opinion as to what is the proper time that should be given to each of these operations. The late Hon. Gideon Lee, in a course of lectures on the art of tanning, declared that he found quick-tanned leather of firmer and closer texture, and at the same time heavier and more durable. By keeping the hides too long in the liquors or vats the gelatin was disolved. But, whatever the general census of opinion, these processes have reduced the time required in the tanning of a hide from twelve and eighteen months to four and six months. Visions of a still greater abbreviation have been common, and "quick tanning processes" appear about so often. Some of these are historical. They include attempts to force the tannin into the hide by

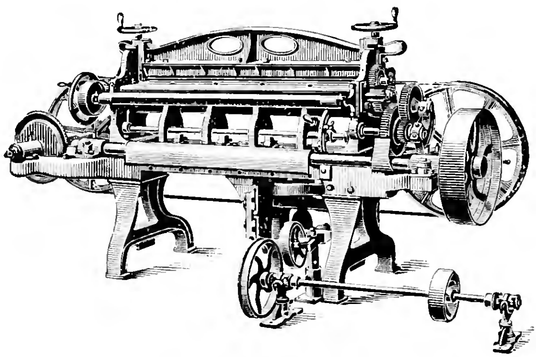

FIG. 9.—BELT SPLITTING MACHINE.

hydrostatic pressure, and by the pressure of the air under an exhausted receiver. They include the application of the principles of osmose and kyanizing. The latter experiment was made by a young English engineer, who in his early life had been engaged in preserving wood by kyanizing with chemical agents. He came to this country and spent ten thousand dollars in constructing a large iron, egg-shaped, copper-lined tank. This was capable of holding one hundred butts, and of resisting an immense pressure. He provided pumps so that he could exhaust the air of this tank, converting it into an almost perfect vacuum, and at the same time force liquor into it, producing a pressure of one hundred pounds to the square inch. Between the hides he placed cocoa matting, so that the free circulation of the liquor should be in no way interfered with. In the top of the tank, where it was impossible to put hides, some small blocks of wood were placed. He afterward exhausted the air in his tank, forced in the liquor, and then waited several days, but his experiment was a complete failure. On examining the contents of the tank, he found the wood thoroughly saturated with tannin, but the hides were scarcely colored. The pressure that would kyanize wood would not tan leather. Recently attempts have been made to employ

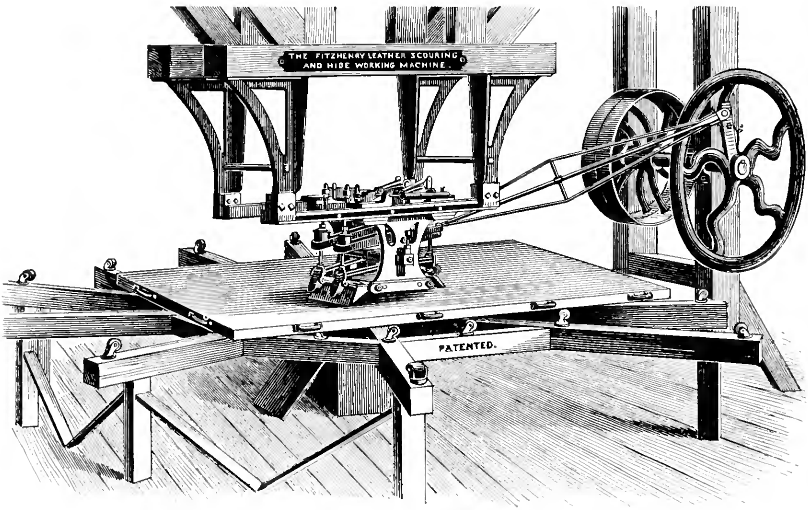

Fig. 10.—Scouring Machine.

electricity to hasten the operation, but as yet no practical and satisfactory "quick tanning" process has been found.

Few, if any, of the pioneer tanneries remain. That, however, which used to belong to Mathias Ogden and Colonel Oliver Spencer, at Elizabethtown, N. J., in 1784, was probably a good example of the original type. That consisted only of forty or fifty oblong boxes, without cover or outlet below, sunk into a bed of clay near a small stream. The boxes did duty as vats and leaches. On one side of them stood an open shed which fronted a half-dozen more boxes, the "limes" and "pools" of the beam-house, while on the other side was a circular trough, made of hewed timber, fifteen feet in diameter, in which the bark was crushed by alternate wooden and stone wheels propelled by two old horses. It was essentially a home-made plant. The wind swept through it without hindrance, and the rain and snow beat unchallenged upon it, hastening the decay of the vats and boxes, and giving an air of desolation to the tannery. But despite all this crudeness, as Bolles has said, and investigation tends to confirm, in this way throughout New England and the Middle States, leather, probably equal to that of any European country except England, was made even before the separation, to an extent more nearly approaching a sufficiency than any other article.

As already noted, the tanner owes more to the mechanic and machinist than to the chemist. In 1793 Deyeux, a French chemist, discovered that tannin was a peculiar body, and two years later Seguin proved that it was the active principle demanded in the operation of tanning. This led to something of a study of the properties of tannin and its distribution. In 1801 Banks, an English chemist, found that it was contained in *terra japonica* or catechu, and since then the list from which it can be extracted, and profitably, too, has been greatly enlarged. The use of liquor containing this active principle of hemlock or oak bark, the "ooze," as it is called, was suggested in England in 1759, but it was first rendered practically successful by Fay in 1790, and Seguin, of France, in 1795. The English had rendered their leather flexible by giving it a thorough beating with hammers by hand. Switzerland, as early as 1800, used water-power hammers, and subsequently replaced them with stamps. Berendorf, of Paris, in 1842, invented a pressing stamp, afterward supplemented by Harvey and Devergue with a roller which accomplished the same thing by passing it back and forth over the leather.

These advances in Europe were not duplicated in the industry in this country. They had their counterparts here, however, and in the end the progress of the Americans, which is measured in this case by the shortening of the operations and the cheapening of the product, kept pace with their craftsmen across the water. Accidents are said to play an important part in the development of any industry. Analyses of these incidents, however, usually show that the accident lay simply in the fact that there happened to be an observing man, of suggestive mind and quick application, about when the occurrence took place. Barrels full of apples probably had fallen before the historic one caught the eye of a Newton. The steam of the tea-kettle might be making music today without any further results had not fertile-minded Watts, or his double, heard it and seen it. In the same way these forward steps in the making of leather came from a combination of ordinary incidents and practical men who saw in them suggestions for better things. One of the pioneers in bringing about these changes in this country was Colonel William Edwards. He built a tannery at Northampton, Mass., about 1790, selecting the

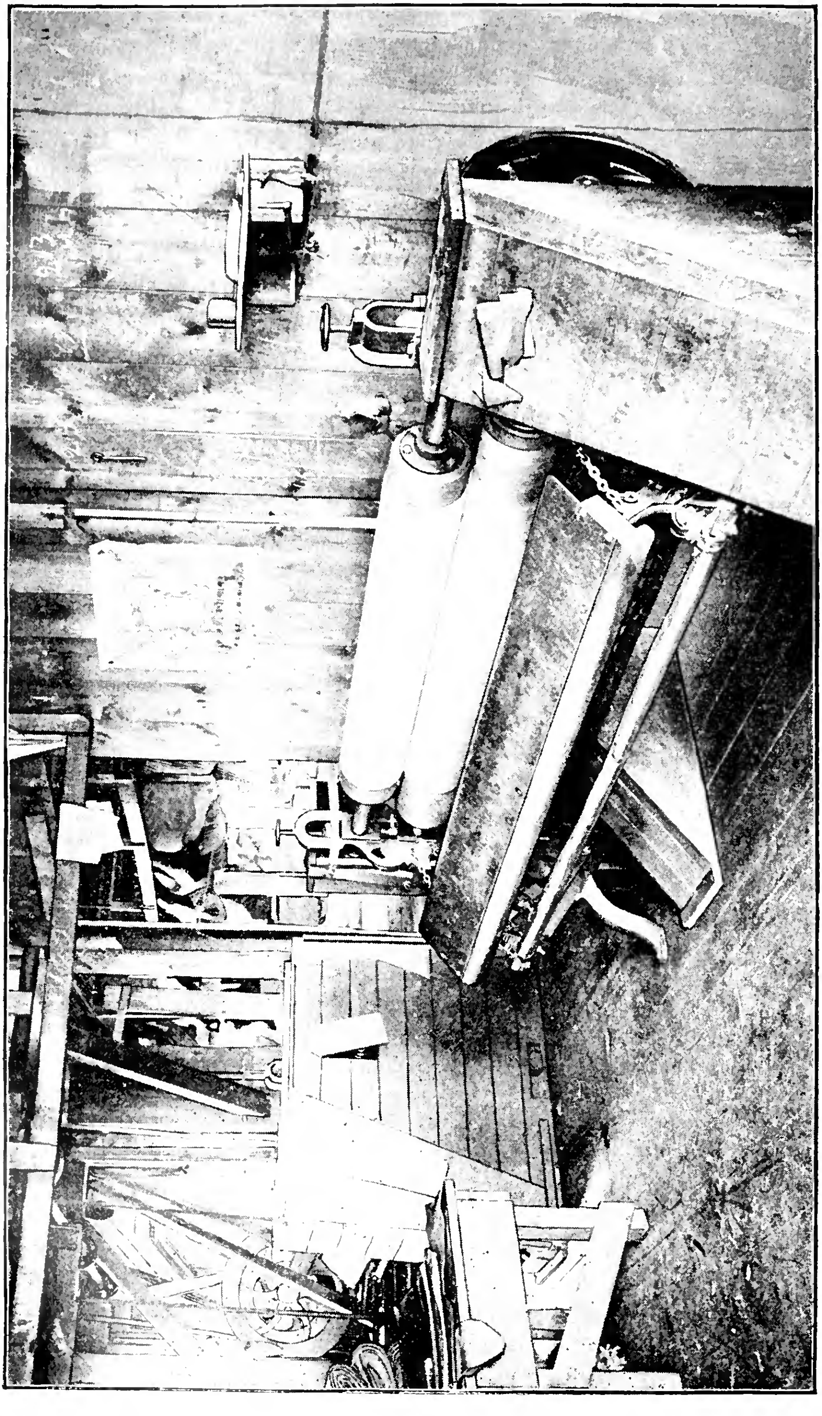

Fig. 11.—Boarding and Graining Machine.

clayey side of a hill for its location. There was a fine spring of water just above his vats, and the natural flow of it was enough to keep them filled. Colonel Edwards's first improvement on the tannery of the day was the making of a place beneath the vats for carrying away the spent liquor. The Ogden and Spencer tannery, it will be remembered, had no provision for getting rid of

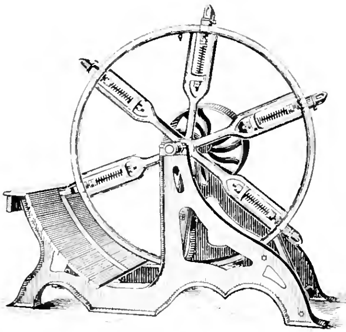

FIG. 12.—POLISHING MACHINE.

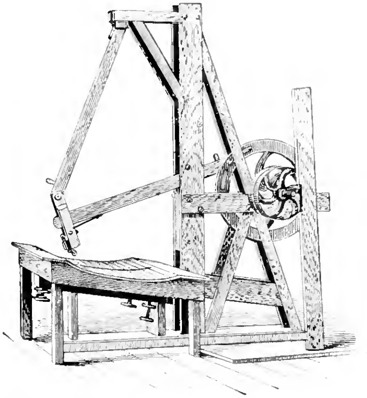

FIG. 14.—PEBBLING JACK.

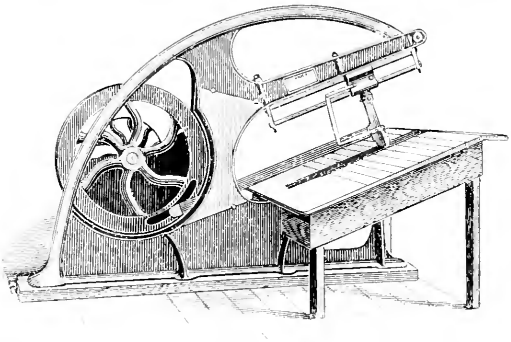

FIG. 13.—GLOSSING JACK.

FIGS. 11, 12, 13, and 14.—A great variety of machinery has been introduced for finishing the leather after it has been tanned. Most prominent among them are those figured above. The object of the boarding machine is to bring up the grain and give a granular appearance to the leather. The other machines are for the details of the process.

that refuse. Colonel Edwards, too, arranged his leaches in tiers, one above the other, and used a suction-pump for raising the liquor. He built a mill for grinding his bark, and, instead of the customary horse as motor power, used water. Perceiving that his leather tanned faster in summer, the application of heat was suggested, and the result was the invention of the copper heater. Dry hides had become very plentiful at that time, and Colonel Edwards had used a stone wheel to soften them. This, however, was a slow operation, and as an experiment the colonel took a few of the hides one day to a fulling mill that was near. The result of that venture was the hide mill. The work of Colonel Edwards was amplified and supplemented by others, until the leather industry had become one of the most firmly established in the country. Of these changes Mr. Pratt, to whom reference has been made, said in 1859:

"From 1815 to 1835 tanneries, which had previously been hostless though not homeless, were provided with roofs and shelter. From 1830 to 1836 we adopted several improvements in manufacturing, among which was a change in the method of unhairing the hides. Discontinuing the use of lime, we adopted, for sole leather, the process of sweating, a method which was falsely patented in this country, having been known in Pennsylvania, Maryland, and Germany. Another improvement was the substitution of fulling or softening in the hide mill in place of the old process of soaking and breaking over the beam. We also discontinued the wasteful operation of skiving, and by these improvements we succeeded in producing at less expense a larger quantity and a better quality of leather. The old method of thrashing the bark was replaced by the rotary grinding stone, and this plan in turn was replaced by the bark mill, invented by Tobey and others, worked at first by horse-power and afterward by steam and water power. As the principles of tanning became better understood, the bark was ground fine, instead of coarse, as before. The old lever pump made way for the press and screw pump; the old slicker of wood, stone, or glass gave place to the rollers made of brass. The water, also, was no longer applied cold to the bark, but heat was added to the leaches, by heaters, pan and steam, and thus the tannin was more effectually extracted. Larger leaches came into use, and the leather was put through a series of baths containing ooze of different strengths. Manual labor gave place to the more economical force of steam and water power. The change from the tanneries of the past to those of the present may be described as a change from chaos to system, from waste, confusion, and long delay, to method, economy, order, and dispatch."

These changes are represented in the hide mill, the bark mill, the splitting machine, the stuffing-wheel, the scouring machine, and the boarding machine. The hide mill was the invention, or rather adaptation, of Colonel Edwards, of Northampton, to whom reference has already been made, and the patent granted him by the Government bears the date of December 30, 1812. The next patent on this mill was not taken out until 1867, the patentee being Mr. J. M. Brown, of Boston, thus showing how comparatively few and slow were the changes in it. The object of these mills is to soften the tough, dry hides so as to render them not only easier of manipulation but readier to absorb the tannin. The mills, as used at the present time, vary in construction according to the grades of leather desired. Some of them are simply great drums, the interiors of which have been stuck over with rows of oak pins. In this way, when these drums are put in motion, the hides, one hundred and fifty to two hundred in number, fall upon the pins and are thoroughly beaten and their fibers loosened. The more common form of the mill, however, consists of a reservoir into which are projected a number of arms or beaters connected by rods to a shaft outside, and this latter as it revolves imparts a reciprocatory vibrating motion to the beaters. But how little advance even this is upon the ancient Egyptian fuller is apparent to

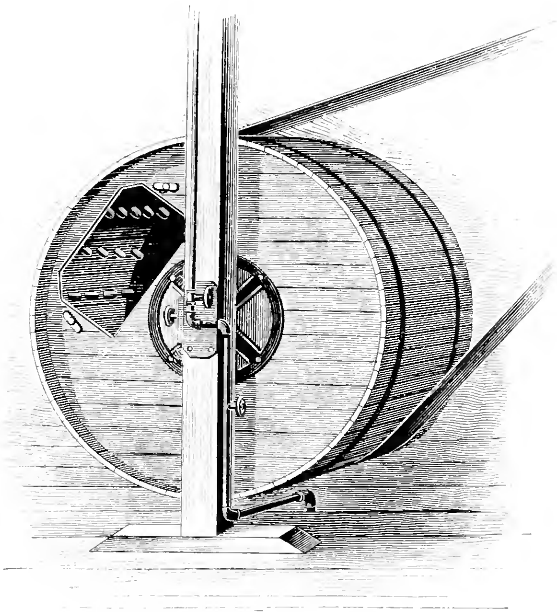

FIG. 15.—STUFFING-WHEEL.

one who will take the trouble to look over some of the old prints. These show the rolls of cloth wetted and manipulated between a block and concave inclined table, with the water passing into a trough at the bottom. These all have their counterparts in the modern fulling or the modern hide mill. The hide mill was introduced among American tanners about 1830, at Salem, but it did not really come into general use, especially among the hemlock tanners of New York, until 1850. Perhaps the invention best entitled to the term "epoch-making" is that of the splitting machine. Indeed, it was the pioneer of the great improvements in the industry, and the effect of it was no other than to revolutionize the currying and finishing business in this country. Previous to its invention the tanned hides had been shaved down to

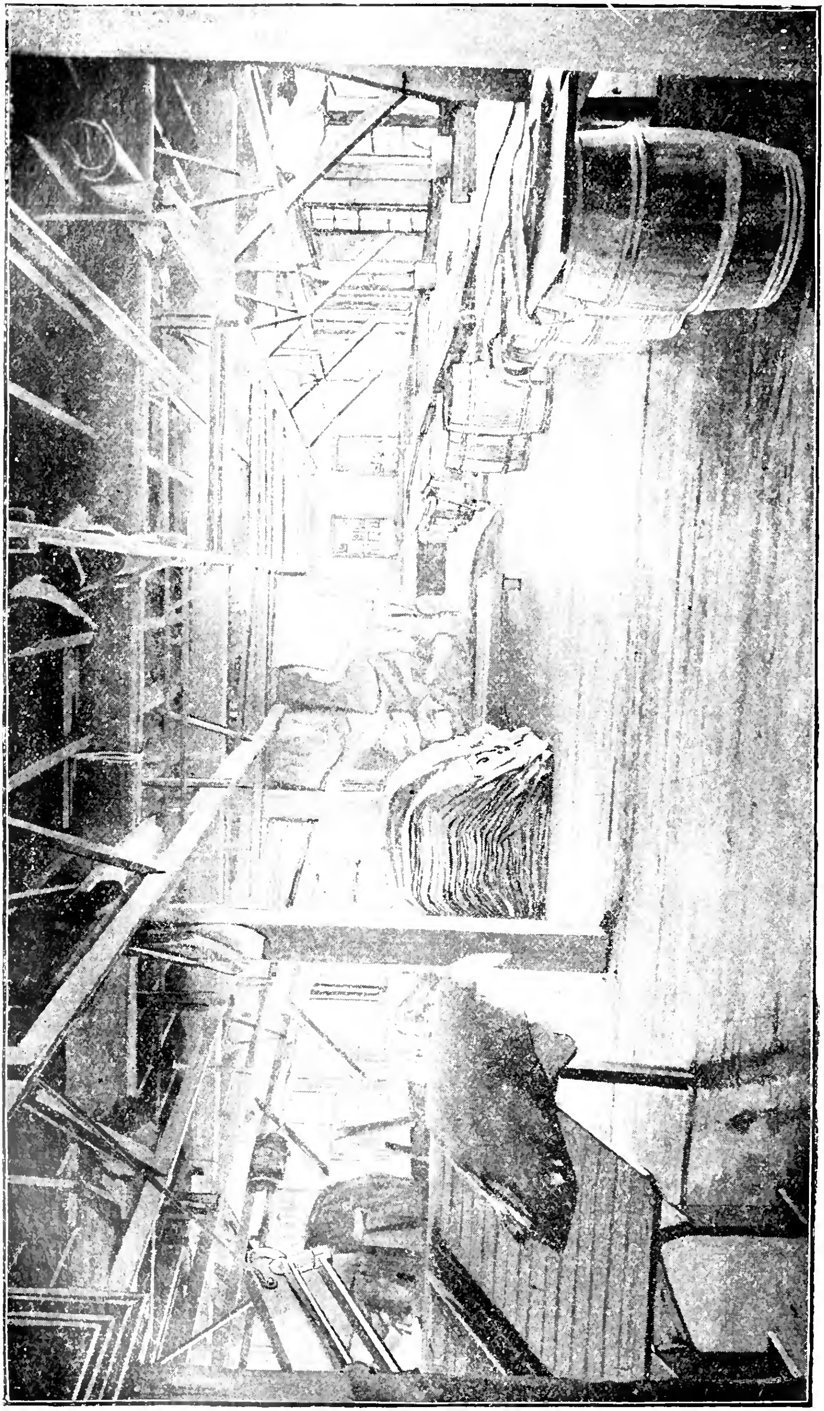

Fig. 16.—Interior Finishing-room in Upper-leather Factory.

the desired thickness by hand, entailing obviously a great waste not only in time but in the large portions of the hide which it was necessary to throw away. By the use of these machines, however, these same hides may be split into two, three, or even five parts, of such thickness as is desired, and each part rendered available. This machine was not really perfected until about 1860. As early as 1800 rough attempts had been made to split leather by machinery, and in 1809 Seth Boyden, of Newark, N. J., secured a patent for such an invention. But there were serious obstacles which

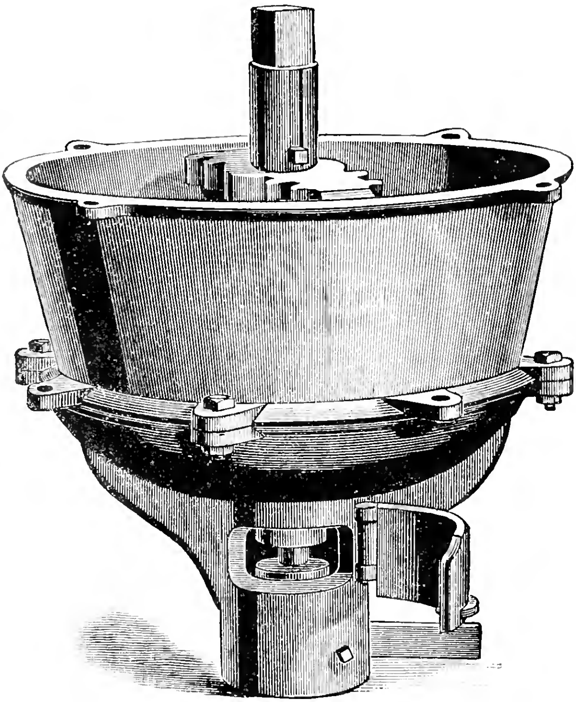

FIG. 17.—BARK MILL.

rendered it impracticable, and it was left to the ingenious mind and skilled hand of Alpha Richardson, of Boston, to overcome them. He secured his first patent in 1831, but he continued to make improvements upon this device until 1856. Then all were grouped, and what is known as the Union splitting machine was the result. This machine is the one which is now in common use among American tanners. Its machinery is somewhat complex. It consists of a small cylinder upon which is placed the hide or leather to be split. As this cylinder turns, the leather is drawn against a sharp knife firmly bolted to the bed of the machine. Above the knife is a stiff spring which holds the leather closely to the edge of the blade, and a gauge-roller, which by means of screws regulates the thickness of the side, and by sectional tubes or rings serves as a friction-roller. When it is desired to split whole hides, a still more complicated machine is employed. This is known as the belt-knife splitting machine, and was invented in 1854 by Joseph F. Flanders and Jere. A. Marden, of Newburyport, Mass. The knife in this machine consists of an endless band of steel, which revolves at a high speed, with its cutting edges close to the sides of a pair of rollers. Through these latter the leather is fed and pressed closely against the knife. The lower roller is made up of a series of rings which are capable of yielding so as to accommodate themselves to the varying thickness of the hides. The thickness of the splits is determined by a small hand-screw, by which the upper roller is raised or depressed as the case may require. The knife itself in its course of revolution comes in contact with an emery-wheel and thus is kept keen. These machines present a blade varying between fifty-seven and seventy-two inches in length, and by them an ordinary cow-hide can be split into three or four distinct parts with the utmost precision.

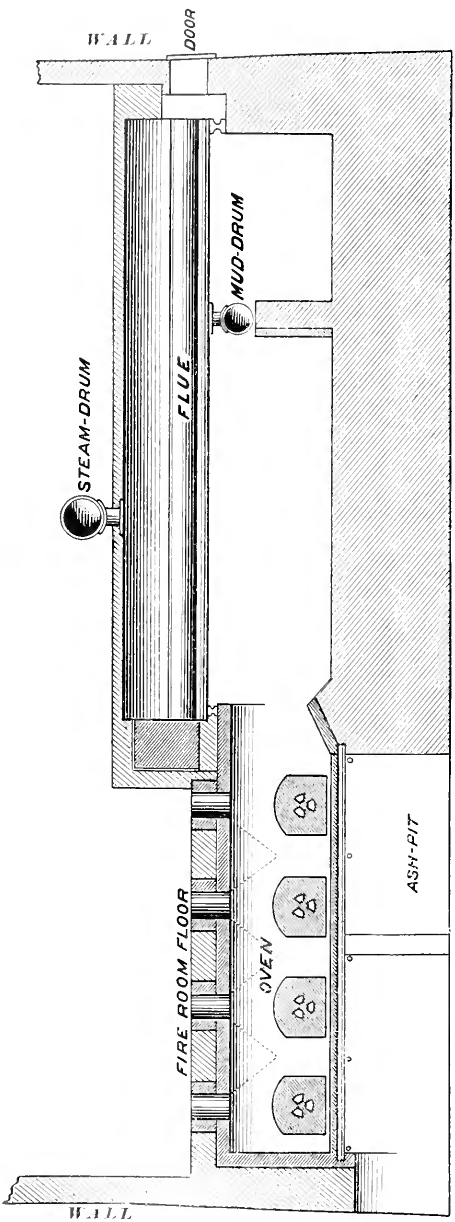

FIG. 18.—HOYT SPENT TAN FURNACE. The above illustration is from the Hoyt furnace at Wilcox, Pa., which consists of two pairs of ovens connected with three horizontal flue boilers. The portion in the cut consists of a section through one of the ovens and one of the boilers, showing the oven, ash-pit, grate, holes for feeding the tan into the oven, the boilers, and the door to sweep out the flues.

It would be impossible to even enumerate the many inventions that have been made to save hand labor and hasten the various processes of finishing. Among the most serviceable is the scouring machine. When the leather is taken from the vats it is usually covered with dust and sediment and stained with resinous matter. Formerly these defects were removed by hand with brush, stone, and slicker; now, however, it is done by "scrubbers" and scouring machines. There is a variety of these, but in general they consist of a level table or platform which is freely movable in all directions. Mounted above it is a reciprocating frame, in which are fixed brushes and pieces of slate and thin stone. By the movement of this, with a small jet of water, the whole surface of the leather is scoured and brushed. Another invention—this to replace the work of the currier in paring and evening and bringing out the grain of the leather—is the whitener. Essentially this machine is like a lawn-mower. It performs its work through the cutting action of a small cylinder with sharp, oblique edges. The cylinder itself moves to and fro over the leather while the knives revolve at the rate of two thousand times per minute. In the machine invented by Mr. Charles Korn, one of the most skillful leather-finishers in the country, these knives are fastened to an endless leather belt, and are set diagonally, so that when the cut is made on the beam as it passes down in front of the operator it is a sliding one. The knives are cleared on the edge by an automatic finger and sharpened by an automatic hand. In the Union leather whitener the belt contains thirty-two knives, while the cylinder revolves 2,780 times per minute, and the pendulum swings to and from the operator at a speed of ninety a minute. These machines can do the work of from four to eight men, and do it as well. Still another finishing machine is the stuffing-wheel, by which the tallow and oil are worked into the leather. This was patented in this country in 1855 by L. W. Fiske, of Louisville, Ky., though it had been previously used in France and Germany. The crude idea of a stuffing-wheel is a revolving hogshead into which the leather and grease are put and a current of steam or heated air passed through. The success of this wheel did much to revolutionize the character of the upper leather of this country. By it the oil and tallow were worked into the center of the fiber, thus making the leather soft and yielding instead of stiff and hard as of old. These devices nearly all had their origin about the time of the civil war, when workmen were scarce in the North, and when manufacturers had to turn their attention to some means of supplying the deficiency.

In point of importance, next to the invention of the splitting machine, stands the discovery of a method for utilizing spent wet

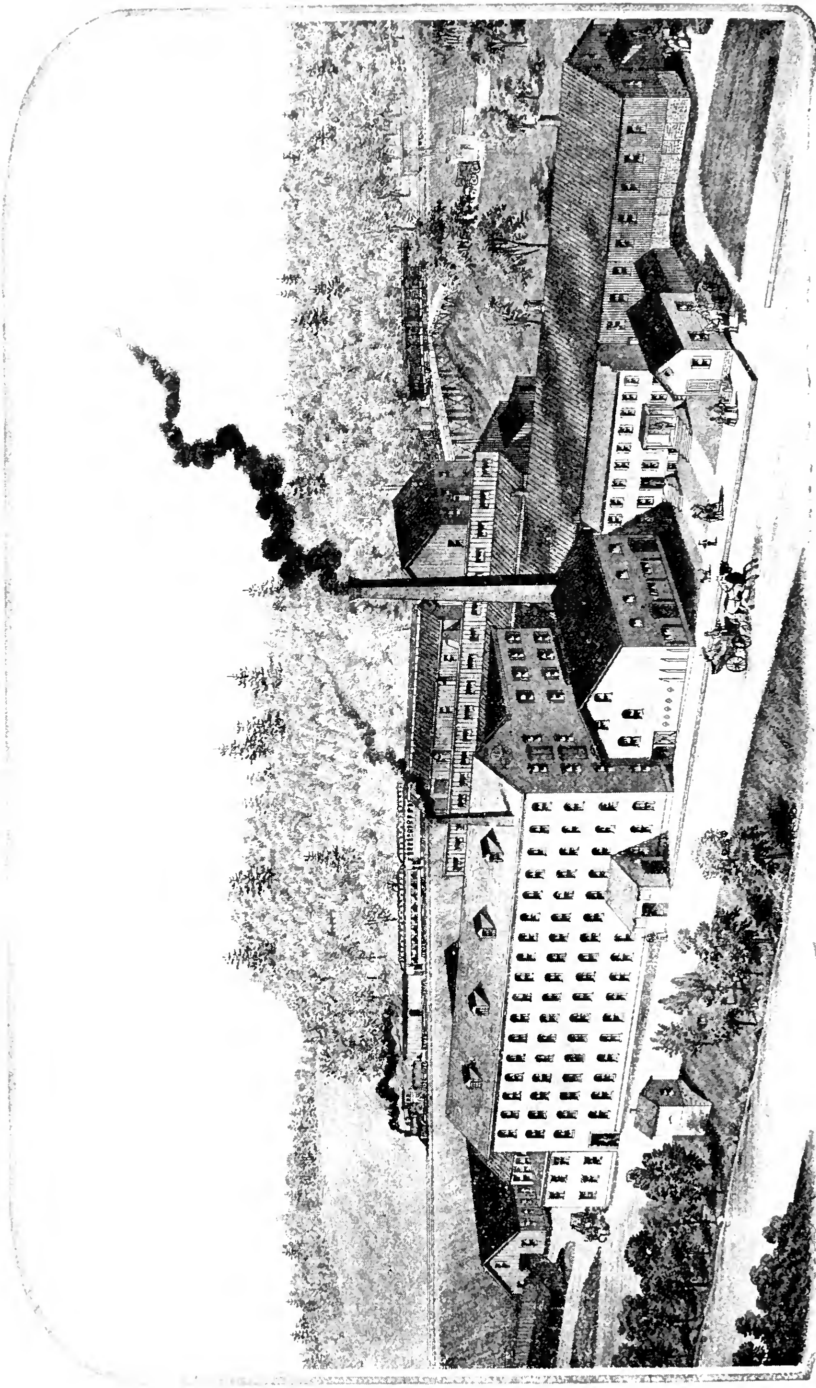

Fig. 19.—Modern Tannery. Haight & Co., Ballston Spa, N. Y.

tan. Both were economical devices. The New England tanners had long been accustomed to dry their spent tan during the summer and store it for winter use. It was then brought into service to heat liquors, and in some cases to generate steam for general tanning purposes. It was found, however, that nearly a half of it was lost in drying. The result was, that attention began to be given to the problem of utilizing it to greater advantage. In 1852 Joseph B. Hoyt conceived the idea that the wet spent tan might be burned in a detached brick furnace. He made the experiment at his tannery in Woodstock, Ulster County, N. Y. After several trials he was successful, and got from the utilization of this hitherto useless product enough power to drive his whole machinery. Since the success of Mr. Hoyt a number of furnaces have been devised for burning this wet tan. That of Mr. Hoyt, as perfected by him, consisted of two pairs of ovens, each pair being connected with three horizontal flue boilers. Each oven, with its boiler, was independent of the other, and each had a separate feed-pipe, steam-pipe, and water-tank. The only things in common between the ovens were the fire-room and the chimney. The ash-pits were the entire width of the grate, and the distance from the under side of the grate-bars to the bottom of the ash-pit was nearly five feet. This permitted a double current of air to form in the ash-pit, the cold one entering at the front near the bottom, passing toward the back end, becoming gradually warmed by the intense heat from the grate, a part entering the oven through the grate, and the rest finally passing out of the ash-pit at the front at a temperature of 300°. By closing the furnace so as to prevent the return current, the temperature of the ash-pit could be raised to 500°. The success of these furnaces worked an immediate change in the whole tannery economy. Hitherto tanneries had been limited to the banks of streams, where they could get good water-power. Now such power was not necessary. Tanneries could be located in the open flats, where access was easy, and where the inconveniences and expenses of elevations could be avoided. Fuel was no longer an item of importance. Tanners, therefore, were not obliged to confine themselves to one great building, but they could spread out into as many smaller ones as their convenience and business demanded. They, furthermore, were no longer obliged to consider the cost of generating steam, and as a result labor-saving machinery commended itself to all. The discovery of this method of burning wet spent tan has been the determining element in the construction of the modern tannery. At the same time it has been one of the most important factors in reducing the cost of the production of leather.

From the definition of leather already given—a chemical or mechanical combination of gelatin and tannin or mineral salts or oil—it is evident that tanned leather is not the only kind of leather. Indeed, there may be said to be three kinds, depending on the constituent elements. There are (1) tanned leather, in which the gelatin is combined with tannin or tannic acid; (2) tawed leather, in which the gelatin is combined with mineral salts; and (3) shamoyed leather, in which the gelatin is combined with oils and fatty substances. Sir Humphry Davy has distinguished between the first of these and the second and third by the statement that tanned leather is a chemical combination, its characteristic being that water will not separate its constituent elements or dissolve their connection, whereas in the case of the others it will return them to their original components. All three kinds of leather are made largely in this country. Tawed and shamoyed leather are used extensively for gloves, clothing, and domestic purposes. Some of the finer qualities have a wide use for fancy finish and ornamentation; but red tanned leather is the oldest in this country, and overtops the others by far in extent and importance, and the processes described have been those pertaining to its manufacture. And there is a wide variety in that. The heavier grades of leather, such as are used for trunks and the soles of boots and shoes, are made from the butts or the back of the hides of the buffalo, ox, and cow. The lighter grades, such as kip or upper leather, are made from the hides of young cattle older than calves and from the hides of a small breed of cattle common to India, Russia, and Africa; while all the spongy leather and morocco, or its imitation, is prepared from sheep and goat skins. These distinctions, however, are only general, but they indicate the lines along which the various branches of the industry divide. American tanners, too, have not been slow about introducing new varieties of leather. Japanned leather, used largely for fancy work and for certain styles of shoes, was first made in this country in 1818 by Seth Boyden, of Newark, N. J. In the manufacture of this the leather is first coated with a compound of linseed oil, umber, and lampblack, applied three or four times, and then is treated to a varnish made of Prussian blue and linseed oil. The leather, which had previously been stretched over frames, is afterward run into ovens heated up to 175° Fahr. Newark, too, was the original home of the enameled leather industry, David Crockett having introduced that finish. This is made much like the japanned leather, except that it is less smooth and less highly polished, the aim being to bring the grain into relief. This is used almost wholly in the coverings of carriages, and it is a branch in which America has always held the lead. Alligator skins were first tanned in Louisiana about 1855, and a considerable business has since grown up in some of the States.

The leather, however, is to be regarded rather as a novelty than as a permanent addition to the industry. American tanners, too, have been quick to learn the methods of making the best of the foreign varieties of leather, and in some cases they have even improved on the original processes. Among these leathers of foreign origin are russia, a strong and pliant variety, generally of a red or black color, and with a peculiarly penetrating odor due to the oil of birch; and Cordovan, a small-grained, soft leather, which takes its name from the Spanish city of Cordova. It was from the gradual modification and improvement of this last that the so-termed morocco leather has resulted. This, with its brilliant colors and beautiful finish, has come to be very widely used. The manufacture of it is carried on in nearly all places where the leather industry flourishes at all, but the centers of the business are at Philadelphia, Pa., Newark, N. J., Wilmington, Del., and Lynn, Mass.

The distribution of the tanneries in this country, and as a result the centers of the leather trade, has been largely determined by the distribution of tanning materials. Tannin, the active vegetable principle of tanning, has been found in a wide variety of plants and trees. As a matter of fact, however, the only substances used largely here are the bark of the oak, the hemlock, and the sumach. Hemlock bark is found generally north of central Pennsylvania, throughout northern New York, north of Lake Michigan, and through Maine and Canada. Oak bark, on the other hand, is found abundantly in the vicinity of the Cumberland and Alleghany Mountains, and the lesser ranges of the Blue Ridge, while the sumach flourishes in Virginia and Maryland. Southern sumach, however, is not so highly esteemed as that obtained from Sicily, and much of this is imported. Some other varieties of tanning materials also are imported, like terra japonica, but the staff of the tanner in this country is the oak and hemlock. It is in those sections of the country that the tanneries are found. New York is the largest general leather market in the United States, while Boston stands close to it, especially in upper leather. Philadelphia, Cincinnati, Chicago, and Baltimore, too, are leading trade centers. The growth of the industry has been very marked since 1860. In 1850 the total product of leather in the United States was valued at $32,861,796, and the capital invested was estimated at $18,900,557. New York State stood at the head of the list, with an output valued at $9,804,000; while Pennsylvania came next, with $5,275,492; and Massachusetts third, with $3,519,123. In 1880 the value of the output had increased to $113,348,336, and the capital invested to $50,222,034. There were then 3,105 tanneries in the country. The position of the six leading States is well represented by this table:

STATE.	Establishments.	Capital.	Hides.	Skins.	Total value of products.
Pennsylvania	642	$15,608,635	2,970,680	635,280	$27,042,068
New York	386	11,710,415	2,503,855	4,171,290	23,652,366
Massachusetts	133	2,712,130	1,625,344	3,724,897	13,536,721
Maine	83	2,439,700	879,160	2,202,158	7,100,967
Illinois	34	2,220,114	395,030	1,486,570	5,402,070
Ohio	302	2,022,990	436,015	434,732	4,357,273

There were, besides this, 2,319 currying establishments in this country, with a product valued at more than $71,000,000. The census figures for 1890 will undoubtedly show even larger increases in production. This increase is reflected in the importation of hides, which for the year 1891 aggregated $27,930,759. During the decade important tanneries have been started in some of the Southern States, and the industry is constantly expanding. This fact appears in the extension of the American leather trade abroad, but this is by no means what it should be. The exports of leather in 1891 aggregated $12,026,556, a gain of a little more than a million dollars as compared with the previous year. Sole leather led, with a sale of 40,084,833 pounds abroad, at a total sum of $6,430,764. It is interesting further to compare the exports of leather and the manufactures of it for the past five years:

Year.	Value of Exports.
1886	$14,865,087
1887	16,235,922
1888	19,578,489
1889	23,712,814
1890	27,000,134
1891	30,736,319

The gain in the exports of leather, indeed, have kept pace relatively with the sale of the manufactures of it abroad, such as boots and shoes. But Americans possess certain important advantages in the making of leather that should give them a stronger hold in the European markets. The continental tanneries have no better facilities for getting hides, and they are handicapped by the lack of oak and hemlock bark which our own manufacturers have at hand. But, despite all this, the leather industry stands among the first in this country in dignity, enterprise, and magnitude. Important advances are yet to be made: but with the natural advantages of our tanners, their thrift and inventiveness, with a constantly expanding home market and a possible foreign one, there appears to be no reason why it should lose its relative rank.

PROPER DIET FOR HOT WEATHER.

By Dr. N. E. Yorke Davies.

THE Englishman is very conservative in his ideas and averse to change in his mode of life, at all events so far as his diet is concerned, and it would not be going too far to say that he is averse to change even where the change is for his good in this respect. The manners and customs of generations gone by with regard to eating and drinking, are the manners and customs of the present age, with this exception that, of course, the refinements of cookery have brought into requisition many delicacies in the way of dishes unknown to our forefathers. The maid of honor in these days does not drink, or have allowed her, a gallon of ale, as did those of the time of "Good Queen Bess," for her breakfast (it is to be hoped she did not consume it), for she now drinks tea or coffee, then unknown. But though her appetite may be the same as in those days, and doubtless even in maids of honor is, custom has altered its constituents. The exigencies of season compel the individual to dress differently winter and summer, so as to equalize the warmth of the body; and to a certain extent most people do this, but it is very apparent that it is the discomfort of feeling the cold that induces them to put on in winter a different kind of dress to that worn in summer. A man would look very absurd if during the summer and the hot months he was seen out wrapped in furs and thick clothing; but though, as I have pointed out in one or two former papers on diet, the heat of the body is better and more perfectly equalized by the food that is taken than by its external covering in the way of clothes, few people adapt their diet to any particular season of the year or its temperature. The ordinary individual eats the same breakfast, lunch, and dinner in spring, summer, autumn, and winter—the same routine of bread, meat, puddings—and the majority of the more wealthy classes consume almost identically the same food, only, perhaps, more delicately manipulated in our time by culinary art. It does not seem to enter into the calculations of the middle-class cook, or the aristocratic *chef*, that there is such a thing as the physiology of dietetics. His aim seems to be to furnish a substantial or delicate meal, pleasant to the palate, utterly regardless of the dietetic value of its constituents, and whether they are more particularly adapted to hot or cold weather. Eating is considered by many, whose intellectual attainments ought to teach them better, almost a religious duty, an irksome one, it is true, as some would say, but one that necessity compels them to perform. My own opinion is that the physiology of food should be taught the rising generation as an important item of school life. If this were so, what a vast difference it would make in the comfort, the health, and the well-being of the individual; and with what a reserve of strength he would, if properly nourished in early life, commence his struggle with the world, whether that struggle involved physical or mental work!

In the first place, his frame would be properly developed, his brain nourished, his digestive powers in perfect condition, and he would not have in his daily work, literary or otherwise, or when old age advances, to fall back upon stimulants to give him the necessary appetite for his midday or evening dinner. Cicero says, "To live long, it is necessary to live slowly." When I say that the physiology of food should form a part of every man's, and, I may add, more particularly of every woman's education, I mean that they should know what particular use each food is applied to in the economy, and what particular food is suited for intellectual work in contradistinction to muscular work; and further, what particular food is best suited to the requirements of the system in the different seasons of the year. Fewer wives would be widows and children orphans if the mistress of a household adapted or ordered her husband's food to meet his requirements, and made it, or saw that it was made, tempting and palatable. But what obtains now in most middle-class households? The husband comes home to dinner weary and hungry to find warmed-up meat, or a washy stew, awaiting him, or, worse still, an underdone joint and half-cooked vegetables. Perhaps this goes on day after day, and year after year, until some day or other an illness occurs, and his constitution, exhausted for the want of proper food to nourish his complex organism, succumbs to it.

In the houses of the very wealthy this state of things seldom occurs—perhaps it would be better if it occasionally did, for a life of indolence and ease would be lengthened by occasional starvation. Half the illness that occurs at one season, I think I can safely say, is due to improper dieting taken at another. We hear of people feeling weak in the spring, or suffering from those different ailments due to malnutrition, such as boils, skin diseases, obesity, or debility. Now this would not be so if the person adapted his diet to his requirements and to the season. No sensible person would think of keeping a large fire burning in his room in the summer. If he did, he would undoubtedly soon feel the effect of it; but many a man who would feel himself insulted if he were not thought a sensible person, will eat in the summer to repletion foods the particular action of which is to supply heat in excess. Perhaps I can not do better here than to explain that the foods that are converted into heat—that is, keep up the heat of the body—are starches, sugar, and fat; and those that more particularly nourish the nervous and muscular system are the albumen and salts; and a perusal of, or reference to, the following table will show what these are, and also the amounts of the different constituents they contain. At a glance the reader will see that the largest proportion of summer food should consist of green vegetables, cooked or as salads; white or lean meats, such as chicken, game, rabbits, venison, fish, and fruits.

Table showing the Percentage Composition of Various Articles of Food.

	Water.	Albumen.	Starch.	Sugar.	Fat.	Salts.
Bread	37	8·1	47·4	3·6	1·6	2·3
Biscuit	8	15·6	73·4	73·4	1·3	1·7
Wheat-flour	15	10·8	66·3	4·2	2·0	1·7
Barley-meal	15	6·3	69·4	4·9	2·4	2·0
Oatmeal	15	12·6	58·4	5·4	5·6	3·0
Rice	13	6·3	79·1	0·4	0·7	0·5
Peas	15	23·0	55·4	2·0	2·1	2·5
Arrowroot	18	....	82·0	....	....	....
Potatoes	75	2·1	18·8	3·2	0·2	0·7
Carrots	83	1·3	8·4	6·1	0·2	1·0
Parsnips	82	1·1	9·6	5·8	0·5	1·0
Turnips	91	1·2	5·1	2·1	....	0·6
Cabbage	91	2·0	5·8	5·8	0·5	0·7
Sugar	5	....	....	77·0	....	....
Treacle	23	....	....	5·2	....	....
New milk	86	4·1	....	2·8	3·9	0·8
Cream	66	2·7	....	5·4	26·7	1·8
Skim milk	88	4·0	....	6·4	1·8	0·8
Buttermilk	88	4·1	....	....	0·7	0·8
Cheese	36·8	33·5	....	....	24·3	5·4
Cheddar cheese	36	28·4	....	....	31·1	4·5
Skim cheese	44	44·8	....	....	6·3	4·9
Lean beef	72	19·3	....	....	3·6	5·1
Fat beef	51	14 8	....	....	29·8	4·4
Lean mutton	72	18·3	....	....	4·9	4·8
Fat mutton	53	12·4	....	....	31·1	3·5
Veal	63	16·5	....	....	15·8	4·7
Fat pork	39	9·8	....	....	48·9	2·3
Green bacon	24	7·1	....	....	66·8	2·1
Dried bacon	15	8·8	....	....	73·3	2·9
Ox liver	74	18·9	....	....	4·1	3·0
Tripe	68	13·2	....	....	16·4	2·4
Cooked meat, roast, no dripping being lost; boiled assumed to be the same	54	27·6	....	....	15·45	2·95
Poultry	74	21·0	....	....	3·8	1·2
White fish	78	18·1	....	....	2·9	1·0
Eels	75	9·9	....	....	13·8	1·3
Salmon	77	16·1	....	....	5·5	1·4
Entire egg	74	14·0	....	....	10·5	1·5
White of egg	78	20·4	....	....	....	1·6
Yolk of egg	52	16·0	....	....	30·7	1·3
Butter and fats	15	....	....	....	83·0	2·0
Beer and porter	91	0·1	....	8·7	....	0·2

I know that I am warring with many established opinions, and I know that the ideas I am promulgating in regard to diet are a little contrary to those generally received; but I think I shall succeed in convincing those who will go carefully into the matter with me that many preconceived conceptions on the subject of diet will not bear investigation. Perhaps the particular condition of the system that I am called upon to treat—obesity—gives me a greater insight into the exact effect of diet than falls to the lot of the ordinary physician or specialist. To begin with, I will assail a time-honored belief—viz., that meat is a *heating* food—that is, in the sense of giving warmth, and raising the heat of the body; and that *farinaceous* foods are the *reverse*. People believe that the less meat they eat in the summer the better, "because it tends to heat the system." Now, it is a curious thing that in dieting people for the reduction of fat by dietetic means only—and this I have to do at all seasons of the year—I am in the habit of cutting off farinaceous foods, sugar, and fat, and giving large quantities of meat, green vegetables, stewed fruit, and other non-fattening substances, in quantity regulated according to the height, weight, and physical or mental work of the individual, male or female, as the case may be; with the result that in the colder months of the year people tell me that they do not feel too warm, clothe as they will. To so great an extent does this sometimes occur, that I am obliged to supplement the non-fattening diet by giving a little heat-forming food, such as cream, or a slightly increased amount of bread, or a small quantity of fat. The result is at once apparent. The body warmth becomes more comfortable. Now, what does this show? It shows that the foods that supply heat are more particularly farinaceous foods, sugar, and fat;* and this is admitted by all dieticians now. If this is so—and it undoubtedly is—it naturally stands to reason that when the external temperature performs this duty, the individual can not require so much food that will, by its chemical decomposition in the body, maintain a high temperature, and, if taken, as is usually the case, in excess, become an incumbrance by being stored as fat. It must be distinctly understood that the argument which I have used, where the heat-forming food is cut off by me, is where the surplus fat in the body is in excess—that is, in corpulency—and when it is desirable to get rid by dietetic means of the accumulated fat in the system. In this case the fat is the storehouse from which the system draws to sustain its warmth, as long as the stored fat is in excess.

A fat animal will live without food months longer than a thin one. A pig buried by the fall of a cliff at Dover was dug out alive one hundred and sixty days after. When it was buried by

* The Eskimo eats twelve pounds of fat a day.

the fall it weighed about one hundred and sixty pounds; when dug out it weighed *only forty*.

Now, with regard to the proper diet for hot weather. In the first place, we must take into consideration the occupation of the individual. A man doing sedentary work or intellectual work would not require the same diet as a person doing laborious muscular work; but this article, in nine cases out of ten, would appeal to the ordinary individual earning his living by the sweat of his brow, or, if I may so say, by the sweat of his brain. If a man earns his living by the sweat of his brain he must, if he wishes to live long, maintain his health by the sweat of his brow, that is, he must, in some form or other, take muscular exercise. He may do it by brisk walking, tennis, bicycling, shooting, hunting, or the thousand and one pursuits that the average Englishman indulges in; so that, as I said before, the diet that I should lay down as suitable for summer will, under these conditions, almost universally apply.

Nature apparently knows what is good for us, and Nature furnishes for the different seasons suitable substances in the way of food. But, of course, Nature assumes that man, being a reasonable being, should study and apply them as he ought to do; but Nature in this case credits man with attributes that in this matter he seldom possesses, or, at all events, does not care to use if he does possess them. Men do not study Nature as much as they should, at least the majority do not. If they did, they would see that in the warm weather fruit should form a considerable portion of the daily food. The most suitable articles for hot weather, experience tells me, are fish, such kinds of meat as fowls and game, green vegetables, salads, and fruit. Farinaceous food, that is, starches, should be taken in the very smallest quantity only. Sufficient sugar would be found in the different fruits that the season of the year produces, and, therefore, should not be supplemented.

In a former article on The Proper Diet for Cold Weather, I illustrated what I meant by giving one or two samples of a day's dietary for an ordinary individual, and I will here do the same. Of course, in an article of this kind it would be perfectly impossible to distinctly draw a dietary suitable to each individual. This can only be done by taking into consideration the mode of life, the idiosyncrasies, the intellectual work, the peculiarities of constitution of a particular person; but in the case of the ordinary healthy person, of course, these distinctions are not necessary. If a man is too fat, he would require certain modifications; if he is gouty or biliously inclined, slight change would be necessary; but, as I said before, to go into this would be unnecessary and out of place, and every intelligent person must alter and adapt the dietary to his means and to his special requirements. Pope says, "The proper study of mankind is man," and, undoubtedly, if long life and comfort are to be attained, many would do well to lay his aphorism to heart. In the case of a man of ordinary size doing ordinary physical or mental work, this would represent an ordinary day's food for hot weather, as far as quantity and constituents are concerned:

BREAKFAST, 8.30 to 9 A. M.—Two cups of tea or coffee, sweetened with saccharine, one or two teaspoonfuls of cream in each; 1 oz. of dry toast, thinly buttered; 4 ozs. of grilled or boiled fish, such as plaice, sole, whiting, haddock, cod, or trout, or 4 ozs. of cold chicken, cold tongue, or of grilled steak or chop.

LUNCH, 1.30 P. M.—Two or three ounces of cold mutton, beef, or lamb; 3 or 4 ozs. of green vegetables, plainly boiled, plenty of green salad, made with vinegar, but without oil; 4 or 5 ozs. of stewed fruit; water, or 2 or 3 glasses of pure dry Moselles or other Rhine wines.

AFTERNOON TEA, 4.30, IF DESIRED.—Two cups of tea as at breakfast; nothing to eat.

DINNER, 7 to 8.—Julienne, or clear vegetable soup; 3 or 4 ozs. of fish; 3 or 4 ozs. of any *red meat*, or of chicken, rabbit, game, or venison; 6 ozs. of any green vegetable, with gravy from the meat only; 4 ozs. of stewed fruit or of raw fruit; a little stale or pulled bread, and a small piece of cheese.

This diet may be varied as to hour; but three meals only should be taken daily, and only sufficient at each meal to satisfy appetite. Fruit may be taken at other times, and any quantity of fluid, so long as it does not contain sugar; any number of pleasant alcoholic and other beverages suitable for the hot weather, and particularly suitable for those who should not take quantities of sugar, will be found in a book I wrote two or three years ago.*

Fruit is only beneficial in moderate quantity. If taken in excess, and out of proportion to other food, it is apt to derange the bowels and cause diarrhœa; more particularly is this the case if it is eaten underripe or overripe—in the former case, from its undue acidity; and in the latter, from its strong tendency to ferment and decompose in the digestive tract. Fruit diminishes the acidity of the secretion of the kidneys, and by virtue of this is advantageous in gout.

It goes without saying that more fluid is necessary in hot weather than in cold. Indeed, so long as it is a harmless fluid, I question whether too much can be taken. Fluid in this way is to the kidneys what fresh air is to the lungs, and the waste of meat not used in the system is carried off by its aid.

A meat diet is healthy and life-prolonging if supplemented with plenty of fluid to carry off its waste. That fluid should be taken in large quantities in the summer is a wise provision of Nature, as the skin carries off a large amount of waste from the

* Foods for the Fat: the Scientific Cure of Corpulency.

system, and therefore its activity should be stimulated in every way, and it is most desirable by frequent baths to keep the pores open. The perspiration drying on the skin leaves a deposit of its salts and other waste constituents, and these should be washed off as a matter of health. A very useful appliance for this purpose is the "massage rubber," patented by Mr. Crutchloe. This consists of a serrated India-rubber surface, and when used it cleans the skin of all scurf as a Turkish bath does, rapidly brings the blood to the surface, and has the conditioning effect that grooming has on a horse. The India rubber seems to act on the skin much as it does in erasing lead-pencil marks from paper, and acts in a way that no towel or brush can equal. All the old loose scurf of the skin is cleared off, and a soft and smooth surface results. After the brisk use of this *dry* rubber, a tepid bath is a great adjunct to health in hot weather, to say nothing of its cooling and refreshing results. I see a well-known man in the Hospital Gazette says the massage rubber acts like a charm in rheumatism.

It would be no use advising those who take stimulants for the sake of their stimulating qualities, that spirits and beers, and certain wines, are too heating in the summer; and that, however suitable port, sherry, spirits, and beer may be in the colder months of the year, the most suitable beverages containing alcohol, for this reason, are those known as the light, dry Moselle wines. Even claret and Burgundy contain a large quantity of tannin, and taken in excess are therefore apt to disagree and derange the stomach. Where a nice dry Moselle is drunk in fairly moderate quantity no harm can accrue. Of course, the quantity that would apply to one person does not apply to another, and a free drinker would certainly not be satisfied with less than two bottles.

The man who lives to eat, drinks after his soup a glass of pale sherry; after his fish, Rhine wine; with his joint, Burgundy and champagne; with the *entrées*, Bordeaux or Burgundy; with the ice, champagne or liqueur, and with his dessert probably some old crusted port. But the man who eats to live would be satisfied with one pint of dry and delicate white wine, such as I have previously indicated, to cover the whole of this *menu*.

It is a well-known physiological fact that the system can not assimilate more alcohol than is contained in a pint of dry Moselle or claret, or in a half-pint of sherry or three pints and a half of table beer, supposing it to be in that form; or, if taken in the form of whisky, about a wineglassful of pure whisky per day. I do not mean to say that an excess of any of these quantities would be absolutely injurious to health, and many might and do exceed them considerably for very many years with impunity; but still, in ordinary individuals, this is the quantity that can be taken with no harm whatever. In some houses people seem to take stimulants at all hours, and only the other day a nobleman told me that, visiting a certain house, his valet came into his bedroom at ten in the morning bringing a pint of champagne. On his telling him he did not want it, his valet said, "If your lordship does not drink it, they will think you are ill!" "His lordship" did not drink it, but the champagne did *not* go down to frighten his host. I imagine gout must be a permanent institution in that household, and that the family vault must be as well stocked as the wine-cellar.

In the summer acidulated drinks are the most grateful to the palate, and in the August number of this journal last year I gave a number of these in an article called Beverages for Hot Weather. There can be no doubt that the most refreshing beverage in summer, and certainly the most harmless, is the properly made cup of tea; but, alas! how seldom does the ordinary English household in England get a properly made cup of tea or coffee! The first cup may be by chance drinkable, or it may have infused half an hour, and therefore contain all the tannin and other disagreeable and injurious products of the leaf. Now, while on the subject of tea, I should like to give a rational and sensible mode of making it for breakfast or other meal with which it may be taken. Any one walking up or down Shaftesbury Avenue, W., will see in a window half a dozen cups that he might reasonably imagine had been bequeathed the establishment by Goliath of Gath. These teacups are called magnums, and they hold exactly a pint, and one of them is sufficient, therefore, or more than sufficient, for a breakfast. To secure a delicious cup of tea, the proper quantity should be put into the teapot according to the number of people requiring a supply, and when it has infused nine or ten minutes —not longer—the magnum, as it is called, should be filled. This being sufficient, and equal to two large breakfast cups, is of uniform strength and flavor throughout. Its contents will please the most fastidious taste and suit the most delicate stomach. In the summer time it should be sweetened with saccharine instead of sugar, and flavored with a little cream. Some prefer tea with a squeeze of lemon-juice in it, and in this way it is possibly more wholesome and suitable as a cooling beverage.

It would occupy too great a space in a short article like this to give the most suitable fruits and vegetables for the summer months to the different conditions of the system. In a dietetic work I wrote some two years ago this subject was fully discussed,* more particularly in relation to those of corpulent, gouty, and rheumatic habit of body.

Three quarters of the ailments that humanity is subject to

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* Foods for the Fat.

undoubtedly arise from errors in dieting, that is, in the quantities of food taken, in its not being adapted to the constitutional requirements and environment of the individual, in its not being properly estimated in its constituents, or applicability to the season of the year; and if, as I said at the commencement of this article, people would take as much trouble in adapting the food to suit their needs as they do in so many other things of minor importance, they would enjoy life more, and see more of it. It is astonishing what a complete change in diet will do. Change in diet acts like change in air, and is a potent factor in the treatment of those conditions that indicate exhaustion of the nervous system, and, as a corollary, general collapse. Man is something like a steam-engine, and he requires fuel according to the work he has to do. The driver of an express train does not have his engine fed as the driver of a slow train does, and so it is with the human engine. The fuel in this case should be to a certain extent adjusted as to whether it is to be utilized for intellectual or muscular work; and if this is done, a large amount of intellectual or physical work may be accomplished without strain. But if these facts are ignored, the complex mechanism on which the happiness and well-being of perhaps even a nation may depend, will collapse like a house of cards.

When the diet is properly regulated for the different seasons of the year in regard to its constituents, there is seldom any necessity to take what some people are so fond of doing, that is, purgative medicines in the spring and in autumn. A little alkaline aperient, such as the "Franz Josef" mineral water, may be taken at any season with benefit by people who live well and who are of sedentary habits, but beyond this it is a mistake to take irritating and powerful purgatives during the early spring and summer, as they are sure to set up diarrhœa that may go on for some time, especially if unreasonable quantities of fruit be indulged in. Fruit in itself is laxative in its effects, and though beneficial, as before borne out, if not taken in excess, will with some people, when more is taken than should be, set up persistent and troublesome irritation throughout the digestive tract. This was one of the evils attending the "grape cure," so much in vogue a few years ago.

In every well-appointed household, dinner is unquestionably the most important meal of the day, and a fashion in regard to this has lately crept into use, which is neither physiologically correct nor conducive to its enjoyment. I refer to the custom now prevalent of commencing dinner with some anchovy toast, caviare, or sardines on bread and butter, or some other savory of a like nature. The proper commencement of dinner should be the old-fashioned dish of good soup, and for this reason: that it is necessary that the first food taken at dinner should be quickly absorbed, so as to stimulate the nervous system and give tone to the stomach. In this way the appetite is stimulated and the sense of taste made more keen. Nothing acts so beneficially for this purpose as a small quantity of good soup. The more important adjuncts are, of course, pleasant surroundings and cheerful companionship.

Contrast the exhilarating effect, say, of a dinner at the "Grand," at Brighton, under the superintendence of its accomplished and obliging manager—with the open sea, and ever-varying kaleidoscope of life to gaze at—with the same dinner in a dull country hotel. Addison says, "Health and cheerfulness mutually beget each other." They undoubtedly do.

To maintain life at its highest standard and for the longest period should be the aim of every individual, and this can only be done by adapting our food to the requirements of the system and the time of the year. If the body is properly nourished, disease will not attack it; and if it does, will get no foothold. It is like an impregnable fortress—it may be assaulted, but it can not be taken.

But to get the economy into this state of perfection, it must be remembered that no more food should be taken than will be consumed in the operations of life, and no more stimulant than the amount previously indicated, so that no surplus of either shall remain in the body in the shape of excess of fat, or as waste, in the form of gout poison or acidity.

"Gluttony," says an old writer, "kills more than the sword." On the other hand, there is no reason why food should not be made as palatable as possible—in fact, the more palatable it is the better. It is not excess in variety of food that is injurious, but excess in quantity.—*The Gentleman's Magazine.*

In his account, in the Australasian Association, of the natives of New Guinea, Mr. J. P. Thomson spoke of their numerous tribal divisions and of the various languages and dialects spoken by them. Even in localities separated by only a few miles, the dialects spoken differ the one from the other in some cases considerably. The Motu, which is the language spoken and taught by the missionaries at Port Moresby, is understood over a considerable area, but outside of that neighborhood changes and variations occur, so that at the head of the Great Papuan Gulf and in the Fly basin, the Motu language is a foreign tongue. In other parts of the island, also, the philological variations are numerous and conflicting; and in the western division neighboring tribes are unable to hold intercourse with each other, even if friendly, by reason of the incompatibility of language. No doubt this may in some measure be accounted for by local environment; constant civil intertribal war is the means of isolating communities, so that no friendly intercourse is held; an incongruity of language may have been unknowingly established by reason of this and other causes.

KINDERGARTENS—MANUAL TRAINING—INDUSTRIAL SCHOOLS.

By Mrs. H. M. PLUNKETT.

In 1877 a prominent Chicago law firm advertised for an office-messenger. In response, more than six hundred college-bred and academy-taught boys applied for the position. In the same year, in the same city, a man engaged in trade put a very inconspicuous advertisement—with no indication that his was a large and old-established house—into an inconspicuous column of a daily paper, calling for the services of an office-boy and messenger. More than three hundred answers were received—many of them from grown men, some of them coming into the category "educated" as commonly understood. Much later than the above date, the position of book-keeper and confidential clerk to a down-town merchant in New York suddenly became vacant. He advertised; more than two hundred applicants responded. "Which one did you take?" queried the person to whom he was relating the incident. "Not any of them; for the fact was that, on my way to my business, I learned of the sudden death of a man in a business similar to my own. I knew that his affairs would have to be closed up, and I knew that he had just the man I wanted—one who understood the ins and outs of the business to perfection; so I just stopped and told the clerk, who was at the moment closing up and putting crape on the door, that when he was at liberty I wished an interview with him, and I thought it might result to his advantage. In a few days he came, and he suits me to a dot." One of these cities it will be noticed was in the young and growing West, the other was in the older and presumably more crowded East.

No doubt these incidents can be matched in most of the large cities of the country, and what is their moral? What message do they convey to the well-wisher of his country or his race? What was the matter with these so-called "educated" men that they could find no place in one of the busiest spots on earth; and why did the merchant ignore his two hundred replies?

Perhaps we need to revise our ideas of what education consists in, and certainly the merchant demanded *trained faculty*, and instantly seized upon it because he knew that he was getting it.

College education, simply of itself, no longer gives a man that pre-eminently superior position that it once did; in addition, he must be able to bring his faculties to bear among the practical and pushing men by whom he is surrounded, or he will be relegated to the limbo of learned incapables, whose pathetic stories come to the surface daily in the column "Situations wanted—males."

The first step in rectifying an error is to probe and analyze it, so as to discover its real nature and dimensions, and the inquiry at once arises, Were those six hundred men really *educated*, or had part of their powers, and perhaps the powers best worthy of cultivation in each individual case, been ignored, or neglected through giving undue attention to the so-called purely "intellectual faculties"?

It may be said that this great army of the unemployed ought to disperse, and betake themselves to the abandoned farms that are crying out for owners and cultivators; but they would be just as helpless and unadapted there, for the simple reason that the taste and skill for farming need to be acquired in youth, and these poor creatures are best described by a word used by a countryman in apologizing for his wife's shortcomings as a housekeeper, "She means well, but she ain't noways *faculized*."

There has been a silent revolution going on for the last fifty years through which a "college education" has been deposed from its position of prime fetich among English-speaking people, and a new set of men—happily named captains of industry—are making their way to the front rank. Never was it truer than today that "new times demand new measures and new men," while it is being discovered that, even for the highest development of what are termed the purely intellectual faculties, book-learning and those studies that can be pursued in the isolated cloister or seminary are not all-sufficient. We are standing in the dawn of a new day, in which the term *manual training* is coming into universal use, and we are destined to hear much more of it and learn much more of its relations to the well-being of individuals and the body politic in the near future.

Between the years 1800 and 1830 a spirit may be said to have been moving upon the waters, in several countries at the same time, to effect a revolution in men's ideas as to the capacities for improvability in man, and the means by which these capacities can be developed, till at length, what may be called the gospel of culture was initiated. Twenty years before the French Revolution, Rousseau had put forth his Émile, a hand-book on education, which was one of those germinal, potent books that, though burned in France, was a seed that brought forth a hundred-fold when it was dropped into the minds of Pestalozzi in Switzerland and Goethe in Germany: it led them to study the human faculties in a new way—to take cognizance of the physical nature, as the concomitant if not the basis of sane and profitable action in the mind. Those men died nearly at the same time, and when England was on the verge of a mighty industrial upheaval; and as the torch of wisdom fell from their relaxing hands, it was caught up in England by men who were scourged to action through fear of a terrific crisis. Its light shot across the Atlantic to safe and peaceful America, and a new style of teaching was inaugurated—largely through the influence of Horace Mann; but this again was improved upon, and brought more into harmony with the fundamental laws of mind by Froebel in Germany—one of his most earnest American propagandists being the venerable Miss Elizabeth P. Peabody—and now it seems as if his ideas are on the verge of universal realization.

In 1831–'32 England was in a state of ferment; incendiaries kept the country lighted up by a line of blazing hay-ricks from county to county, cattle were poisoned or mutilated, and every day brought news of some fine machine broken up by the factory people, as a devouring monster that had come to eat the bread out of their mouths, and the real oppressions and fancied injuries of the factory population had become so unbearable that Parliament could no longer remain apathetic and supine.

In 1833 a commission was appointed to examine into the condition of the labor of young persons and children employed in factories. The commissioners found generally that the children were worked during the same stages as adults—eleven, twelve, or more hours daily—and this long-time labor had practically excluded the children from the means of education, so that a population had been growing up deteriorated morally as well as physically by excess of labor. Sir Edwin Chadwick was charged with the work of drawing up a bill that should remedy the evils of their condition. The commission declared that six hours of daily labor was all that young children could endure without permanent bodily harm, and insisted that manufacturers enforcing work during those long hours should do it with double sets of children, six hours to each set. The provision which Mr. Chadwick proposed as an efficient protection to these little factory slaves against exclusion from education was, "that it should be a condition of the employment of children by the manufacturer that every child so employed should produce a certificate from a competent teacher in a fitting school, certifying that the child had been under instruction three hours every working-day during the week preceding; three hours being half the time then generally occupied in the working-schools. Hence the name "half-school-timers," which soon shortened into "half-timers." These three hours' schooling—much of it in inferior or nominal schools—was primarily intended as a security from overwork, for it was reasoned "Three hours in the school-room keeps them out of the workshop three hours," and the immediate effect, as testified by competent medical men, was a better growth; and, quite unexpectedly, employers admitted, a better quality of work. But, over and above these results, there came out of these investigations and measures some surprising revelations and practical results, which eventually affected the whole of the prevalent practice of infantile and juvenile training and education. The graded school and the trained teacher were partially the incidental outcome of a work primarily undertaken to rescue mentally and physically the young factory slaves. There were a few enlightened and humane employers, permeated with the progressive spirit of the time, who established schools in connection with their works, and there were some good schools kept by trained teachers in the large manufacturing towns, as at Manchester and Oldham, where the half-timers could be sent. Mr. Chadwick made a careful study of the best conditions for mental work among twelve thouands pupils, during a period of twelve years, and has left on record some very surprising but accurately thought-out conclusions. He thinks that alert voluntary attention is the only profitable attention, and he is sure that "three hours is as much time as can be occupied profitably with any subject-matters of instruction, with very young children," but it was found that the half-timers got a superior habit of mental activity, so that employers came to prefer short-timers to long-timers, and the military drill that had been introduced in the schools resulted in such superior bodily aptitudes that the stunted pauper boys of town got the preference over strong, robust rustics from the coast; but the most surprising result remains to be stated, for it soon began to appear that in mental attainments the half-time factory boy was in advance of the pupils of the board schools of the same age, the factory boy attaining the fourth standard by his tenth year, while the "long-time" board scholar reached it in his twelfth or thirteenth year.

In 1882, after half a century of observation and experiment, Mr. Chadwick summed up some of the defects of the current systems in words too apt to be improved upon. He says: "Unfortunately, the primary principle of education, the capacity of the recipient, *the mind*, is not understood or regarded. . . . The receptivity of the minds of the great mass of children, for direct simultaneous class-teaching—the only effective teaching—is less than three hours, and where these limits are undistinguished and disregarded, the consequences are displayed in wearisome efforts, as it were, to get quarts into mental capacities of pints and gallons into quarts, with prolonged sedentary detentions for this foolish purpose, and with grievous bodily as well as mental injury."

Meantime, educators have now settled these points:

1. The inadequacy of the old-fashioned college education to enable the average man to take and hold a place among the world's needed workers—those six hundred applicants in Chicago prove this.

2. They have entirely changed their views as to the relation of the bodily powers to mental training; and—

3. They have changed their views as to the right time in which to lay the foundations of moral character.

While these advances were being made in the science of pedagogy the human body—as a means of development for the mind and soul—began to be discovered; and, instead of its being regarded as a mere shell or scaffolding wholly outside and apart from the unseen nature, it was found out that the "sound body" in which the wisest of the ancients lodged their "sound mind," had much to do with the growth and perfection of the spiritual nature.

In April of 1891 some of the leading educators of this country held in Boston a conference on manual training; and we make no apology for copious extracts from the phonographic report of their addresses, as they contain the latest utterances of the persons best qualified to speak on the theme we are considering.

Said President Eliot, of Harvard: "The wisdom of my parents caused me to be taught carpentry and wood-turning before I was fifteen years old—while I was yet a member of the Boston Latin School. It has been of great use to me all my life, and a great pleasure. Then, later, after graduating at college, I became a chemist by profession. I studied that difficult science for years, and then I taught it for years. In every science a great deal of manual skill is necessary for the student and the teacher. The progress of the world in natural science during the last century has been greatly due to the trained senses—eyes, ears, noses, and fingers—of the experts in those sciences.

"Then for the last twenty years I have seen that one of the great improvements which have been wrought in education in all civilized countries has been the individualization of instruction so as to meet the precise needs and develop the capacities and powers of each individual, at each stage of his development.

"I am old enough to remember when the brain was supposed to be the seat of the mind, just as the lungs were held to be the furnace that warms the body. I remember being taught that the animal heat was kept up in the lungs, but we all know better now; we know now that whenever an atom is consumed, in whatever part of the body, there heat is generated, and therefore that the animal heat pervades the whole organism. It is just so with regard to the human mind: it pervades the body. It is not in the head, but it is all over the body, and when you train the hand or the eye or the ear, you train the mind: manual training is mental training. Never admit that manual training is anything distinguished from or in opposition to mental training. In the skill of the artist's hand, in the methodical, accurate movement of the mechanic's arm, in the acute observation through the physician's eye or ear, there is always mind. We are, in manual training, simply training another kind of faculty—not memory, but discriminating observation and correct perception. The old-fashioned education was chiefly devoted to the training of memory; most of the work in the grammar school to-day is memory-training. I am thankful for every effort to train our youth to correct observation, just discrimination, and accurate measurement.

"There is another value in manual training in that it trains the mind through success, through achievement, through doing something tangible and visible and doing it well. When a boy has planed a parallelopiped of iron so well that no light shows under the edge of his try-square when he applies it to the faces of the block, he has done something which demands patience and care and attention, something which he can prove to be well done —something which he be proud of. There is mind in such work, and there is also sound morality in it."

Sir Edwin Chadwick says: "It is proved practically that the physical training in the school stage, giving the use of hands, arms, eyes, and legs, is giving aptitudes for *all* industrial occupations"; and, also, in commenting on the military drill as introduced largely through his influence in the public schools in England: "The physical exercise in the military drill is a visible *moral* exercise in all that is implied in the term discipline—viz., duty, obedience to command, order, self-restraint, punctuality, and patience. There is good and bad elementary moral education, as shown by the outcome, and especially by the outcome of the half-time system of education; but the half-sedentary or intellectual and dogmatic education, and the half-physical, has now been proved to be far more successful than any other system yet known or practiced."

The eminent manual instructors all over the country echo this experience, as above set forth, by two of the foremost authorities among English-speaking people.

During the last twenty years, and especially during the last ten, the great army of Christian men and women, who have been striving to uplift humanity, have been revising and modifying their views as to the *best time* in which to begin setting young feet in those right paths that shall lead them to usefulness and happiness; and the general consensus of opinion is that between the years of three and six is the most precious seed-time for the implanting of moral principles—that then is the time for "bending the twig" effectively. One of the men in New York of the largest experience among the children of the neglected and criminal classes says, "We find that all we can do for their moral improvement must be accomplished before they are twelve years old, and we find that the earlier we begin the better."

An instrument seems to be provided in the *kindergarten*, in which a thoroughly thought-out science of instruction adapted to the child-mind is put in practice with children as soon as they show a longing for the companionship of other children; it is an institution which bridges over the chasm between the nursery and the school.

Philanthropists, looking at human material as a whole, perceive that true economy of force concerns itself with forming, thus preventing the need of reforming. It can be demonstrated from the money standpoint alone, leaving out of view the inevitable misery involved in the latter process.

In New York city there are now 142,519 children under five years of age whose homes are in the tenement-houses. The latest report of the New York Kindergarten Association states the cost of conducting a kindergarten of fifty pupils at fourteen hundred dollars per annum—twenty-eight dollars per capita. At the Elmira Reformatory it costs one hundred and eighty-eight dollars per annum to support one of these children whose manual and moral training has been neglected after the commission of some crime has placed an indelible stain on his name. Mr. Brockway states that very few of these young burdens on society have "any acquaintance with any craft requiring skilled labor, and their parents are just as deficient"; so that the earnest men and women who are now striving to lift the metropolis of the nation toward the level already attained by Boston, San Francisco, St. Louis, and a host of other cities by the establishment of free kindergartens, are taking possession of the largest and most hopeful missionary field still lying unoccupied under the broad arch of heaven. Mr. Gilder truly says, "Plant a free kindergarten in any quarter of this overcrowded metropolis, and you have begun, then and there, the work of making better lives, better homes, better citizens, and a better city."

Pestalozzi saw that the moral forces of the human soul—feeling and will—require to be dealt with in a manner analogous to the cultivation of the intellectual faculties, that a training school is needed for the moral side of cultivation—one in which the power of moral action may be acquired. He said, "There must be a definite system of rules by which always without exception a firm will may be produced"; and the Baroness von Bülow adds, "The development of children into men and women must be brought under the laws of a well-considered system, which shall never fail to accomplish its end, viz., the cultivation in them of a firm and invariably right will."

In discussing the necessity for the kindergarten, physiology and psychology unite in crying out against the waste of the years from three to six. Says Prof. Bain, in his Education as a Science: "The brain grows with great rapidity up to seven years of age. It then attains an average weight of forty ounces in the male; from that time it grows, but at a diminishing rate, till twenty, when it has nearly attained its greatest size." It would seem pretty clear that there is some connection between intellectual power and brain-growth. Whatever it can take hold of, it can fix and ingrain with an intensity proportionate to its rate of growth, and we begin too late if we allow time to pass by when good and useful impressions could be made with perfect safety to physical and mental health, and nearly all thoughtful teachers and psychologists agree that for certain classes of impressions the first six or seven years of life are worth all the rest put together: it is at this period that curiosity to see and to know is at its intensest."

In the town of Christchurch, England, we hear of children under six put to making the delicate chains that connect the mainsprings of watches to the works, because when older their fingers are too large and clumsy; and of still smaller ones in London who are made to rub in the nitrate of silver used in dyeing sealskins, because their tiny slender fingers can pass effectively in and out among the hairs; but there can be no delight in this work to the poor child-slave, such as is felt in the kindergarten, where, seated at a table in company with others of his own age, the child plaits strips of straw or leather or colored paper, or models from clay a nest of birds and its eggs, or forms a miniature house and garden and fence, from pretty materials after a pattern of his own designing, in which his mind has passed through the natural stages of perception, observation, comparison, judgment, conclusion, and production. Then a pretty song, descriptive of some incident or process, in which all join, is followed by mild gymnastic exercises adapted to the childish frame, and thus, as the Baroness von Bülow says: "In playful work or workful play the child finds a relief for, and a satisfaction of, his active impulses, and receives an elementary groundwork for all later work, whether artistic or professional." Many of the articles made are intended as special gifts for some birthday or for Christmas, or they are sold to procure the means of dressing a Christmas tree for some poor or sick child, for it is one of the fundamental principles of the system to teach the child consideration for others, and also to give him a true respect for useful work—"work which is at the same time a fulfillment of duty is the only true basis of moral culture." But it is necessary that such work should satisfy the child's instinct of love, and the object of it must be to give pleasure to others, and a system of education such as is demanded by modern times should make work such as shall connect artistic dexterity with the cultivation of intelligence its basis. A writer in the Philadelphia Times, commenting on the public-school "education" as conducted mostly hitherto, says: "Nine tenths of the young criminals sent to the penitentiaries have enjoyed school advantages, but three fourths of them have never learned to do *an honest stroke of work*. Our children have their poor little heads crammed full of all kinds of impossible knowledge of names, of dates, and numbers of unintelligible rules, until there is no room left to hold any of the simple truths of honor and duty and morality." The military trainers declare that they obtain in the very infantile stages (five years) a better drill than they do or can get afterward, and Chadwick says: "The drill conduces to qualities of a high moral order and value, denoted by the terms discipline, patience, order, self-restraint, prompt and exact obedience. Children so trained learn to move quickly together and to pull together, and exert force with fewer hands."

It would thus seem that three of the most valuable years of a large majority of our children have hitherto been allowed to run to waste, and, as the educational policy of a country should be directed toward developing all its intellectual wealth, a movement which seems to be "in the air," that will eventually graft the kindergarten on to the common-school system of the whole country, should be hailed with joy by the patriot and philanthropist.

There are already thirty-nine in St. Louis in connection with the public school, thirty-eight in Philadelphia, twenty-two in Boston, twenty-two in Milwaukee, and from five to twelve in other cities. If a good many thousands of the unoccupied young women of the land would learn to be first-class kindergartners, and each, gathering a dozen or more of the neglected children now crowded out of the schools about themselves, and bestow some of their unused capacity for "mothering" upon them, what a prophylactic it would be against the corrupting "reformatory" in later years, and perhaps the penitentiary!

Now that really wise and discriminating educators affirm that, in the time beyond the kindergarten years, the use of the hand is not antagonistic to intellectual achievement, but rather promotive of it, we are beginning to hear the phrase *manual training* on every hand, the more because that, for successful *pueri*culture as a factor in national life, we must, as Chadwick says, "add to the science of the physiologist and the psychologist that of the political economist, by whom man is regarded as an intelligent productive force"; and in another stage to which we are advancing—that of the general use of machinery—Jules Simon defines man as "an intelligent director of productive force, valuable to the extent and quality of its yield." Five thousand persons are killed by steam power and machinery in England and Wales annually. Sir William Fairbairn says: "These deaths are mostly occasioned by the ignorance or clumsiness of the hands to whom machines were intrusted; occurring singly as they do, and making monotonously similar newspaper paragraphs, we become brutalized and fail to take in the enormity of the destruction." America could show no better record; it is as if ten times the number of persons who make up both Houses of Congress should be brought together and visibly blown to pieces, scalded, and crushed, by bodily clumsiness and defective training. In England, for lack of the kindergarten or infant school, fifteen hundred children are scalded or burned to death each year, and probably more in America.

What is manual training? It is the subjugation of the hand and arm (an appendage of the head) to the direction of the brain, so that they shall touch some definite point, or exert some definite measured force, in obedience to the will, at the exact instant desired.

When should it begin; and what are likely to be its effects on the common weal?

The human hand is, of all instruments, the most wonderful. Sixty years ago Sir Charles Bell, the great anatomist, who discovered that the nerve filaments of sensation are distinct from those of motion, wrote a volume on The Hand, its Mechanism and Endowments, as evincing Design. In the intervening years so much has been learned of the relation of the nervous elements to the muscular fibers which they animate and control, and so much of the effects of the interaction of the brain and hand in those processes which we call "reflex," that another and most interesting volume might now be written on the hand in these aspects. It has been definitely ascertained that there are certain limited areas of the brain which control and direct the motions of certain limbs and no other; and as in the production of certain definite motions—e. g., those used in sewing or piano-playing—this definite related area of the brain is called into exercise, why may not its repeatedly being aroused to action promote its growth and perfection as surely as exercise of the blacksmith's muscle causes its growth and the perfection of its finely compacted fibers?

But, speculations aside, experience proves that the education of the hand can be begun at three years in the kindergarten, so that the child, whose supple and growing fingers have been taught to move in definite directions for definite ends, has at six a long start in manual dexterity ahead of the child whose maturing joints have been neglected. Our great-grandmothers taught their daughters to make "fine shirts for papa," neatly and thoroughly, at what seems to us an incredibly early age; and now that the hand as an element in human development is again being discovered, it is interesting to find that the highest specimens of plain sewing, shown as "prize exhibits" in the public schools where sewing is taught, is a tiny pair of old-fashioned shirt sleeves, made with straight, doubled and stitched wristbands, gussets overhanded on and felled, and neat gathers, made by the formula "skip four, take up two," and "smoothed" *secundem artem.* The girl who never uses a needle till twelve years old can not become a facile seamstress. Every one is familiar with the early age at which professional acrobats commence the training of their children. There may be an inherited muscular aptitude, but the parents do not rely upon that to make their son into an "infant prodigy." No one needs be told that musical performers must get the music "into their fingers" before they are stiffened and full-grown. These persons illustrate best of all the subtle, inexplicable connection between brain and hand. What undivided attention does the neophyte give to the striking of each separate note on the piano. Those who have listened to much "practicing" know how tiresome it is, until by unremitting iteration and repetition there comes a day when, lo! the fingers glide over the keys, touching each minutest fraction of a note perfectly—each in obedience to its own nervous impulse—while perhaps the performer is answering your questions on an entirely irrelevant subject. Mozart had absorbed a knowledge of music by listening to the lessons given his sister Maria, and had undoubtedly experimented by himself till at four he played the piano with ease and expression; and his father having given him a small violin at six, he learned by himself how to play it, so that before he was seven he played his part in a trio, reading at sight without mistakes or hesitation. The musicians certainly know the value of manual training and give a fresh emphasis to the old adage "practice makes perfect." Rev. Dr. Parkhurst, in commenting on the accuracy of aim with which David's stone "smote the Philistine in his forehead, that the stone sunk into his forehead," an aim that presents itself to many minds as supernaturally aided, said: "*But it wasn't his first stone;* he had practiced while out there on the plains of Bethlehem watching his father's sheep, and the unerring shot was the legitimate result of long training."

There is another aspect in which the introduction of machinery needs to be considered by his country's well-wisher. In the Boston Conference on Manual Training, Colonel C. W. Larned, of West Point, said: "There are altogether too few men in the world who are skillful to do with their hands—not to talk, or to write, or to imitate—but to perform with skilled faculties; the eye of that much-traduced creature, the average man, is becoming more and more dull and indiscriminating, the hand increasingly unapt and inexpert. The more machinery and the artificialities of life relieve the individual from the responsibilities of physical action, the more the faculties will suffer from atrophy, for the reign of the machine has a dulling effect upon the general acuteness of the physical faculties that must be progressively felt, unless education systematically counteracts its influence; and it is the function of industrial training to do this for the hand-worker."

But the greatest injury which comes to the body politic through neglect of training in the most impressionable years is the failure to impart moral ideas, and to secure habitual obedience to moral laws—lack of character-building. The half-time schools of England have been so long in operation that their statistics furnish conclusions of the highest value; and, that book-learning is no guaranty of the moral worth of its possessor, look at the criminal returns for London for one year. The education of some was "superior"; among the criminals there were more than a thousand clerks, forty-two lawyers, and many more who had received the usual middle-class, long-time education. The appearance of a half-timer trained on the mixed principle of physical and mental training is exceedingly rare, that of persons from some of the religious denominations equally so—showing the thoroughness of their moral teaching; while the governor of one prison said, "The greatest rascal I have in custody can write out our Lord's prayer in seven languages." The ancient Jews—while still living in Palestine—had a maxim, "He who does not teach his son a trade teaches him to be a thief." Mr. Chadwick collected some facts that should bring great encouragement to those who have been moved to labor for the salvation of the slum-born children of the criminal classes. It was shown that in some of the long-time middle-class schools twenty per cent of the pupils were disqualified from obtaining positions by misconduct; while among pupils of low parentage in good half-time schools, these dismal failures averaged only two or three per cent; and that, too, where, before the establishment of such schools, the average had formerly been as high as sixty; and a manager of one of the district half-time schools stated that he had had cases of habitual criminality to treat—that in a few months a great alteration in their characters had taken place through their industrial training. I asked if, say, a hundred such were committed to your charge, how many could you undertake to send to the good?" He said, "With fair support, I would undertake to send ninety per cent to the good."

Under the restraints of separate confinement in the prison the thoughts of the young criminal are not compunctious visitings for wrong-doing, but of his ill luck, and the chances of escaping detection in ill-doing when he gets out; and this child of the beggar or thief, with no skill in hand or arm for work, sees no way but to do as he has done before. In the half-time industrial school he is placed under new conditions, by which good thoughts are impressed from day to day to the exclusion of bad ones: he becomes grounded in the primary moral principles of attention, patience, self-restraint, prompt and exact obedience; hope springs up in his poor crushed soul, as he gets interested in his work and does it with a will. There is enough accumulated experience in England and America to warrant the statement that the most profitable investment that can be made in "futures" is in those of the living children of the country by making the kindergarten and manual training part of the public-school system throughout the broad land. It would undoubtedly add much to the cost of education, but it would be more than offset by lessening the cost of reformatories and the support of criminals. More, it would afford useful and congenial employment for thousands of women—for it is really impossible to imagine a man's becoming a successful kindergartner; the teacher in that school needs to be endowed with the divine instinct of motherhood, and succeeds because she follows it, just as a good trained nurse succeeds through her inherent I-must-care-for-somebody characteristic. A doctor of wide experience predicts that the movement for the training of masculine nurses will be a comparative failure, simply from lack of this foundation element in the pupils. There are now good training schools for kindergartners, where all that can be imparted by teaching, to supplement natural ability can be learned; and we venture to declare that the most promising missionary field in the world is to be found on the outer fringe of our large cities, where in a narrow tenement the mother has her *creché* on her lap and her "kindergarten" and her "primary" and "secondary" pupils at her side, all under the age to be admitted in the public school. What more natural, when the smallest goes to sleep, than to send the others into the street, where they must perforce learn its evil lessons? In the city of New York there are many thousands of these children. Suppose that one thousand young women, well instructed in the art of teaching according to Froebel's system, should each gather about her a score of these undisciplined waifs, teach them till they were six, and then pass them on to a school where manual training is mixed with "book-learning" in the measures experience has demonstrated is wisest, to be taught till twelve—it would result in the greatest salvation from evil, and in the greatest addition to the working capacity of the generation, that could be made.

In 1870, at the solicitation of Miss E. P. Peabody, the Boston School Board established a kindergarten and conducted it for several years; but it was to another woman's enthusiasm and her private munificence that the cause was to owe its conquering impulse. In 1877 Mrs. Quincy A. Shaw opened two; and from time to time others were added, till in 1883 she had established in Boston and its vicinity thirty-one. In 1887 the Boston School Board, having become convinced of their value, incorporated fourteen as part of the public-school system, and others have been gradually added, till now it has thirty-one, with an attendance of nearly two thousand children. But this children's crusade is by no means confined to Boston; there are kindergartens and manual training schools in St. Louis, in Philadelphia, in San Francisco, and, in short, they are taking root all over the country. Nowhere are they so much needed as in New York, where there is annually so much ignorance dumped from abroad; but, until there is not a single score of neglected, untaught children left unreached by this beneficent agency, let us hear no more wailings over superfluous womanhood. Where is the practical philanthropist who desires to leave noble men and women as his monument, who will supply the funds needed to rescue these children, while the municipal authorities are waiting to be convinced of the utility of not opening the stable-door at all, when thieves are about?

If there is such a waiting benefactor of his kind, there is plenty of accumulated experience to guide him in the choice of instruments. Lest those who have failed in other fields should fancy that here is a niche that they can fill, let them understand that it needs a high order of talent to succeed here. Mr. Chadwick says, "Those who have given earnest study to primary education are aware that the highest training power should be applied in the most formative period—the infant-class"; and in the report of the Boston conference we read, "One strong feature of Mrs. Shaw's management, perhaps the one which raised the educational value of the Boston kindergartens, was the extreme care exercised in the selection of teachers"; and whenever the kindergarten is to win its way, this care must be exercised. In 1883 she induced two kindergartners of St. Louis, each excelling in a special line, to come and give advanced courses to her teachers, and these were supplemented by lectures, teachers' meetings, etc.

Manual training—still in the dawn of its development—has come, and come to stay. It will enhance the respect due to honest labor, and go far to cure the disease of "millionism" from which we are just now suffering; and those who look to the Scriptures for guidance will remember that the brilliant reasoner and follower of the carpenter's son, St. Paul, was a tent-maker, who called the elders of Ephesus to witness that "these hands have ministered to my necessities, and to them that were with me."

TWO RARE MONKEYS.

By Dr. L. HECK,

DIRECTOR OF THE ZOÖLOGICAL GARDEN IN BERLIN.

THE slender and the short-thumbed monkeys belong, in the truest sense of the word, to an old simian family. The fact is demonstrated as to the Indian slender monkeys, for indubitable representatives of this genus (the *Semnopithecus*) lived in the Tertiary period.

The form of the skull gives the slender and short-thumbed monkeys a peculiar appearance. It is roundish, the snout advancing but little in front of the forehead, and the bony crests and edges, which often give the skull of the male an appearance like that of a beast of prey, are hardly distinguishable. In a corresponding way the jaw is relatively only slightly projecting, and less obvious in the slender than in the short-thumbed monkeys. The entire skeleton in both groups is distinguished by the slenderness and lightness of its form, from which the slender monkeys get their name. The name of the African short-thumbed monkeys relates to a peculiarity of their bony structure, in that the thumbs of their fore limbs are not visible externally except as stumps; and, while in the slender monkeys, too, the thumb is behind the other fingers in development, the complete arrest of it in the others has been held sufficient to mark a distinction between the two families. On the other hand, I find a peculiarity of the skeleton of the slender monkeys mentioned in only a few descriptions, and in those casually, which appears to me as doubly striking in the monkeys as climbing animals, and is not elsewhere repeated in them, at least in those of the Old World. It is that the slender monkeys have much longer and thicker hind legs than fore legs; the development of the hind limbs evidently surpasses that of the fore limbs; and this occasions characteristic deviations in the attitudes and movements of the animals, as I have observed daily with my pets. The slender monkeys run half erect with their hind legs bent up, and make great leaps from this position direct. Thus, notwithstanding their great agility, they have something hasty and angular in their motions, and maintain so peculiar a gait that any one who has studied them continuously in living specimens can distinguish at a glance whether a picture of them is made from life, or whether it has been constructed by adding a few special outward marks of the slender monkey to the figure of a common monkey. In their inner structure the slender monkeys and the short-thumbed monkeys have a highly important peculiarity, unique in its way, in the shape of a composite, divided stomach, suggestive of the ruminants, or rather of the kangaroo,

FIG. 1.—WHITE-BEARDED SLENDER MONKEYS.

which is sufficient, in my opinion, despite some special differences, to characterize them as closely related. This peculiar structure of the stomach, unprecedented in a monkey, naturally induces the presumption of a peculiar method of feeding, and indeed shows indubitably that the slender monkeys and the short-thumbed monkeys are more fully and exclusively vegetable feeders, or, to be more exact, greens-eaters, than the other monkeys. This inductive conclusion is fully confirmed by observation of the animals in captivity. Our representative of the short-thumbed monkeys, the *guerezas*, as well as the two species of short-thumbed monkeys which I have tamed, eat regularly but daintily of the hay that serves them for straw and bedding, and the guerezas eat with particular relish the heads of green salad which they have learned to expect eagerly for their daily supper. In outer general appearance, which is chiefly dependent on the character of the hair coating, the slender and short-thumbed monkeys exhibit some important peculiarities which distinguish both groups, while the Indian slender monkeys generally have a short fur and their hair makes a conspicuous growth only in spots in the shape of head-tufts, manes, whiskers, and gorgets. The African short-tailed monkeys are distinguished by a long, luxuriant hair covering over the whole body, the effect of which is enhanced by handsome and conspicuous markings. The more delicate differences of hairiness, coloring, and marking serve, in both groups, to fix the distinctions of a considerable list of species. We shall confine ourselves chiefly to the species represented in the pictures.

First, we have the two comrades so pleasantly sitting together on the limb in Fig. 1. They are White-bearded Slender monkeys (*Semnopithecus leucoprymnus*, Desm.) of Ceylon, the single species which has been brought to Europe with considerable frequency, and which is therefore easily found in the zoölogical gardens. This harmless, quiet, gentle animal is easily distinguished by its external appearance, which is felicitously in harmony with its name. It has a white cheek-beard, with the tips of the hairs turned forward. The lower part of the back and the tail are grayish white. The rest of the body is brownish black, while the hair on the head is longer and more distinct. Sailors can always buy these monkeys cheaply in the port of Colombo, and they are probably common on the island.

In Fig. 2 are moving some representatives of a famous species of monkey, the Hulman or sacred monkey of India (*Semnopithecus entellus*, Cuv.). This monkey is accredited with having performed great acts of heroism in primitive times. It is in the Indian mythology a kind of Perseus and Prometheus in one, inasmuch as it delivered a goddess from captivity to a giant, and used its opportunity to give to India, not fire, but the mango. It extinguished the funeral fire on which it was to have expiated its rash adventure, and therefore appears now with singed face and black hands. The rest of its body is colored a whitish gray; on its forehead, cheeks, and chin it wears long, stiff, bristling hairs, out of which, as from a frame, peers the round black face with a lively and peculiarly droll expression. The pious Hindu, who will kill hardly any animal, of course does as little harm as possible to his ardently revered monkey-saint, but gives it freely of the fruits of his gardens and fields. He even in a literal sense lets it take the already prepared meal from his own mouth. Through the credulous simplicity of men, which has permitted them in quiet acquiescence from time immemorial to do their pleasure, the hulmans have become so bold and impudent that they go into the houses as well as into the gardens and steal, plunder, and destroy at their hearts' desire. In many parts of India they have become a real plague, and the English officers are at times obliged, in order to limit the nuisance, to proceed against the tail-wearing saints with destructive measures, to the joy of the enlightened, intelligent natives, but to the disgust of the

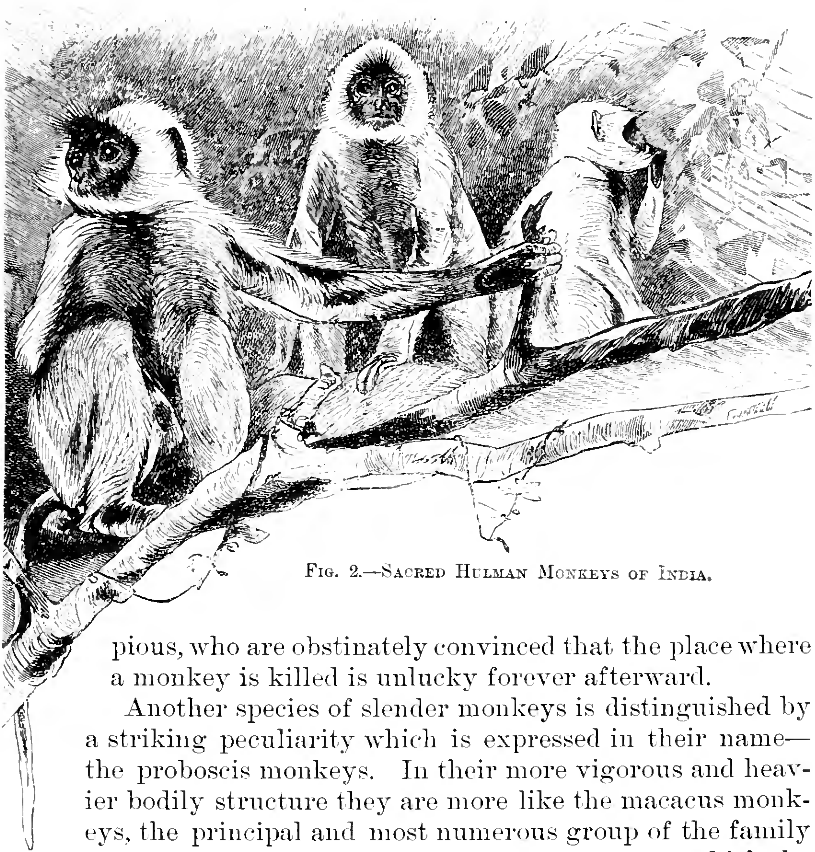

Fig. 2.—Sacred Hulman Monkeys of India.

pious, who are obstinately convinced that the place where a monkey is killed is unlucky forever afterward.

Another species of slender monkeys is distinguished by a striking peculiarity which is expressed in their name—the proboscis monkeys. In their more vigorous and heavier bodily structure they are more like the macacus monkeys, the principal and most numerous group of the family in the Indo-Chinese region, and the one, too, to which the mass of the population of our monkey-houses belong.

The proboscis monkey (*Semnopithecus nasicus*, Cuv.), in the outer development of its nasal organ, so surpasses all the monkeys and even all men that it has been set off as a distinct genus solely on account of this feature. It lives in the island of Borneo. The longitudinally furrowed, hook-shaped, flexible nose, impending over the mouth and an inch broad in the middle, is peculiar to the old male. Females and the young have instead of it only a small, depressed pug-nose. The tufted monkeys also deserve to be mentioned on account of their outward resemblance to the short-thumbed monkeys, which is given them by the long, rich hairiness of the whole dark-gray body, even of the under side and the exposed surfaces of the hands and feet. On the head the hair is prolonged and erected in a peculiar way to form a long, stiff tuft, or rather mane, which extends down to the neck. Its habitat is in Farther India (Siam) and the larger Sunda Islands (Java and Sumatra).

The most prominent members of the group of South African short-thumbed apes is the guereza (*Colobus guereza*, Rüpp). This monkey is one of the most famous animals, and one of those which are most fully and imaginatively described in all special works and portrayed in plain and in fantastic styles; so that every owner of a natural history knows it by name, but nobody has seen it living. We do no wrong to truth when we say that the first guerezas which were seen living in the European public were the three specimens which were carried in a drosky in August, 1890, before our offices in the Berlin Zoölogical Gardens. A Greek had brought them from Massawah to Berlin, but our privilege of becoming acquainted with them is due chiefly to the disinterested intervention of Herr Menges, a much-traveled dealer and the director of the Somali exhibitions. I paid a considerable sum for them, and am not sorry for it, for, although none of these specimens is living now, they made students, artists, and friends of animals acquainted with one of the handsomest and most remarkable creatures known, and gave them opportunity to make the first correct pictures of it from life. The picture makes a more detailed description of the coloring of the guereza unnecessary; and I will only say that the way in which the white appears, as in a certain sense a border and trimming of the dark ground color, varies somewhat and might probably afford a means of distinguishing between the geographical varieties of a species that is distributed over the whole of interior Africa. Hans Meyer, the hardy conqueror of Africa's giant mountain Kilima Njaro, found in that region a form which he named *caudatus*, in which the whole tail is white; our specimens belong to a variety called *occidentalis* in Rocheprune's monograph on the short-thumbed monkeys. A considerable number of species of monkeys of western and central Africa are pictured and described in this special work; many of them, including the bear short-thumbed monkeys (*Colobus ursinus*, Waterh.), look much like a guereza without a side-mane; others, like the devil-monkey (*Colobus satanas*, Og.), are described as black; and still others are red. Of all these we know little except concerning the skins and the skulls, for they reach us living only exceptionally. I return to the guereza, the handsomest and most interesting species.

The trio of them which I got, all three young, perhaps half-grown fellows, were distinguished by something pretty and pleasing in their behavior, and a similar account is given of them by those who have observed them in the wild state. The guereza

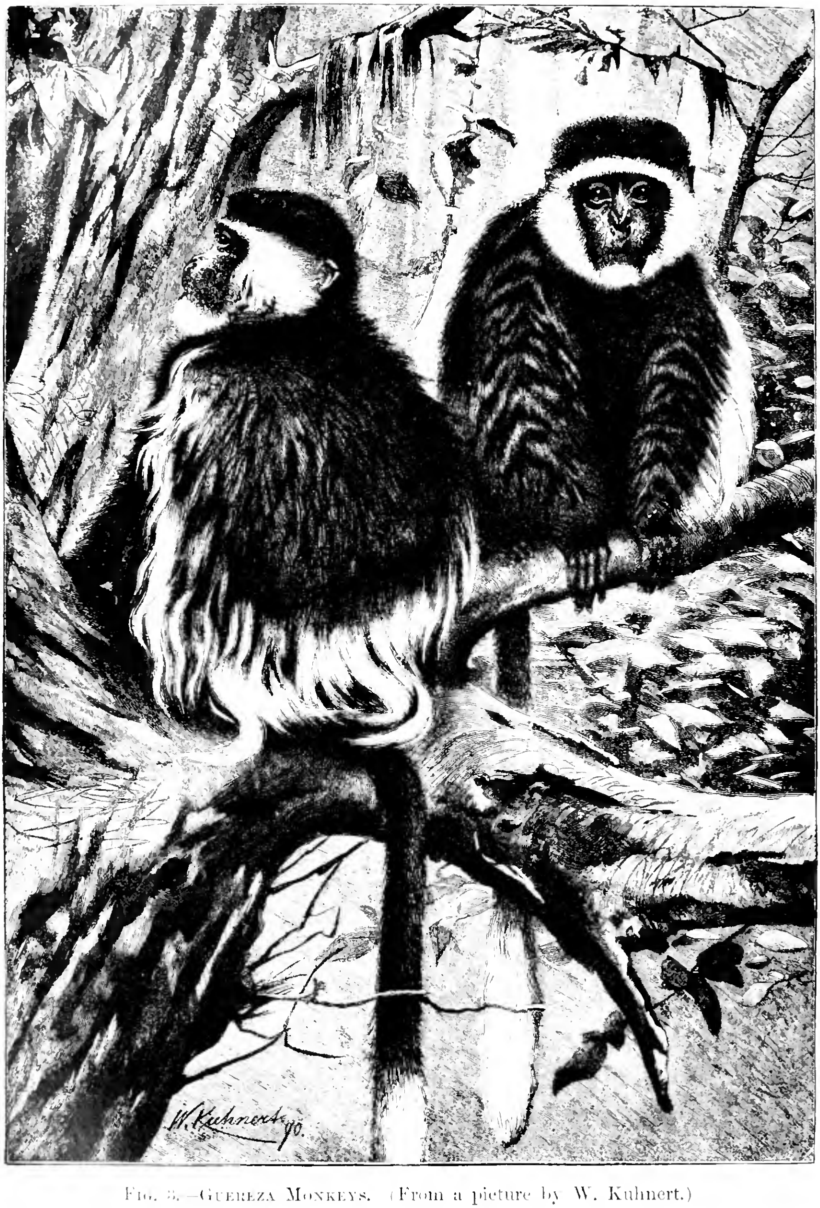

Fig. 3.—Guereza Monkeys. (From a picture by W. Kuhnert.)

is not one of the hated field robbers, and it has therefore been hunted in Abyssinia only so much as is necessary to get material for the adornment of the small, round leather shields formerly in use there. These shields have gone out of use since the style of armor has been changed, and it is now molested but little, and leads a peaceful life away from the dwellings of men. "In Galla-land, whence your specimens have come," Menges writes to me, "the guereza lives in the thick woods, especially in deep, moist, and warm mountain gorges. It prefers a home in the giant sycamore trees, or wild figs, the fruits of which constitute its principal food. The Abyssinian juniper, which is from twenty-five to thirty metres high, and forms whole forests there, is also much resorted to by it." Brehm, relying upon the unanimity of the accounts which have appeared since the discovery of the guereza by the Abyssinian traveler Rüppell, of Frankfort, enthusiastically praises the beauty, gracefulness, and elegance of the outward appearance of the animal and the agility and grace of its motions, especially its colossal leap, in which the body seems to be carried along by its waving robe. Hans Meyer unconsciously complements this sketch with a description of the quiet, still life of the societies of four or five members in the secure height of their tree-top, and in connection with it mentions a habit not to my knowledge observed before, by which the presence of a band of guerezas can be recognized from a distance. It is a monotonous, sing-song humming, with an alternating *crescendo* and *diminuendo*, proceeding from the members of the families sitting lazily together, and to all appearance expressive of complete satisfaction. Perhaps it was because of the absence of this satisfaction that I never heard this humming from my pets. They usually kept themselves quite still, and were accustomed only to greet their beloved greens with a peculiar cry toned between the whimper of the capuchin and the crowing of the young mandrill. With this we have come to the end of our observations on these two peculiar families of monkeys which have been crowded away into the background in our zoölogical gardens by their livelier, more striking, and more hardy congeners. But we hope that what we have said of their remarkable organization will be enough to make them seem worthy of some attention from the animal-loving reader.—*Translated for The Popular Science Monthly from Die Gartenlaube.*

One of the incentives that send explorers so often back to their work was described by Captain Younghusband after relating to the English Society of Arts the story of his experiences in the Pamirs. Like most travelers, he said, he had often thought he should not go again on such arduous adventures; but when the traveler returned to his native country, and saw that an interest was taken in what he had done, and that people would still be interested in further journeys he might make, he felt his energies renewed and was quite willing to undergo the hardships which must necessarily befall him, feeling that he was doing something for his government and his country.

"NEW" AND VARIABLE STARS.

By J. ELLARD GORE.

TO ordinary observation the light of the stars seems to be constant. Although of various degrees of brilliancy, the brightness of each individual star appears to most people to be invariable. This is, of course, true with reference to the great majority of the stars which deck our midnight sky. There are, however, many objects the light of which is subject to considerable fluctuations. These are known as variable stars, and form one of the most interesting classes of objects visible in the stellar heavens. Over two hundred are now known to be certainly variable in light, and many others have been suspected of inconstancy. In some of these stars the changes of brightness can only be detected by careful watching, but in many the light is variable to a considerable extent. In the variable star Chi Cygni, for example, the star's light at maximum is about sixteen hundred times the light at minimum. At its brightest it is sometimes fairly visible to the naked eye, whereas in its faintest phase a pretty good telescope is required to see it at all.

These most interesting and mysterious objects have been divided into different classes, according to the character of the light-variation and the length of the period which completes the cycle of their curious changes. The classification now generally adopted is that proposed by Prof. Pickering, of the Harvard Observatory, U. S. A. This includes five classes, which are as follows: 1. Temporary or "new stars"; 2. Stars with regular periods of considerable length; 3. Irregular variables, having no definite period; 4. Variables of short period—say, under thirty days; and, 5. Variables of the type of Algol, or those which, at regular intervals, undergo a sudden (or comparatively sudden) diminution of brightness lasting for a few hours only, the star remaining constant in light (or nearly so) during the remainder of its period. A short account of these different classes may prove of interest to the general reader.

1. "Temporary" or "new stars" are perhaps the rarest phenomena visible in the heavens. Comets—at least, those visible to the naked eye—are rare celestial visitors. *Telescopic* comets are, however, tolerably numerous, and scarcely a year passes without the discovery of several of these faint objects. Very few "new stars" have, however, been recorded in the annals of astronomical history. I refer, of course, to those which can properly be termed "new"—that is, stars the existence of which was previously unknown to astronomers, and which, blazing out suddenly, remained visible for a short time, and then faded away without again obtain-

ing a maximum of light. Considered from this point of view, these *novæ*, as they are termed, can not correctly, perhaps, be classed among the variable stars at all. They appear once only, and then die out, never to return; at least, no return of a true *nova* has yet been recorded.

A remarkable peculiarity about these temporary stars is their usually sudden appearance. In all the well-authenticated cases the stars have blazed out with startling rapidity. Such were the brilliant stars of 1572 and 1604; and in later years, those of 1866 in Corona Borealis, and of 1876 in Cygnus. Tycho Brahe's star of 1572 made its appearance near the star Kappa Cassiopeiæ, the faintest of the four stars forming the well-known square in Cassiopeia's Chair. It appears to have been first noticed by Cornelius Gemma, on November 9th of that year, and it seems to have blazed out very suddenly, as he states that it was not visible on the preceding evening in a clear sky. The attention of Tycho Brahe, whose name is generally associated with the star, seems to have been first attracted to it on November 11th. When first seen, it surpassed Jupiter and rivaled Venus in brightness, and was visible at noonday! At this brilliancy, however, it did not long remain, but gradually diminished in luster, and in March, 1574, had completely disappeared, at least to the naked eye. Its curious changes are thus described: "As it decreased in size, so it varied in color; at first its light was white and extremely bright; it then became yellowish, afterward of a ruddy color, and finished with a pale livid color." Tycho Brahe has left an elaborate record of his observations of this wonderful object in a work of no less than 478 pages of printed matter.

"Kepler's *nova*" of 1604 appeared in the constellation Ophiuchus in October of that year. The planets Mars, Jupiter, and Saturn were near each other in this region of the heavens, near Eta Ophiuchi, and one evening Brunowski, a pupil of Kepler's, remarked that a new and very brilliant star had joined the planetary group. When first seen the new star was white, and exceeded in brilliancy Mars and Jupiter, and was even thought to rival Venus in splendor. It gradually diminished, and in six months was not equal in brightness to Saturn. In March, 1606, it had disappeared. It was also observed by the famous Galileo. Kepler wrote a work on the subject, which is still preserved. Only faint stars are now visible with the telescope near the positions assigned to these bright stars of 1572 and 1604.

In 1670 a star of the third magnitude was observed by Anthelm near Beta Cygni. It remained visible for about two years, and increased and diminished several times before its final disappearance.

A small temporary star was observed by Dr. Hind in Ophiuchus on April 28, 1848. When first noticed it was about the fifth magnitude. It afterward rose to nearly the fourth magnitude, but gradually faded away. Hind was certain that up to April 3d or 5th no object of even the ninth magnitude was visible in the position of the new star. This curious object is still visible, but has become very faint in recent years. In 1866 it was of the twelfth magnitude, and in 1875 not above the thirteenth magnitude.

On May 28, 1860, a new star was discovered by the late Mr. Pogson in the globular cluster known as 80 Messier in Scorpio. When first seen it was about the seventh magnitude, and nearly blotted out the nebula by its superior light. On June 10th the star had nearly vanished, and the cluster again shone out with its usual brilliancy, and with a condensed center. Pogson observed the cluster on May 9th, and noticed nothing remarkable; and, according to Schönfeld, it presented its usual appearance on May 15th in the heliometer of the Königsberg Observatory.

The star of 1866, known as the "Blaze Star," suddenly appeared in Corona Borealis in May of that year. Although it was subsequently found that the object had been previously observed and registered as a small star by the famous German astronomer, Argelander, it presented at the time of its discovery all the characteristics of a true *nova*. It seems to have blazed out very suddenly, for at about 9.30 P. M. on the evening of the 12th of May in that year Prof. Schmidt, observing the constellation Corona Borealis at Athens, saw nothing peculiar. Indeed, he afterward expressed his conviction that at that hour a star of even the fifth magnitude could not possibly have existed near the position without immediately attracting his attention. Within three hours afterward—about midnight—it was discovered by the late Mr. Birmingham, at Tuam, Ireland, shining as a star of the second magnitude, and rivaling in brilliancy Alphecca, "the gem of the coronet." Its light, however, rapidly faded. On May 14th it was of the third magnitude; on May 19th, only of the sixth. On May 24th it had become invisible to the naked eye, and by June 9th had faded to the ninth magnitude. When near its greatest brightness its light was examined by Dr. Huggins with the spectroscope, which showed the bright lines of hydrogen gas in addition to the ordinary stellar spectrum. During the ten years following this extraordinary outburst of light, Schmidt observed fluctuations in its brightness, which appeared to take place with a certain regularity. It would therefore seem that this object should be considered as an irregular variable rather than a "temporary star." Its rejection from the list of "new stars" would remove the only exception to the rule that all these wonderful objects have appeared in or near the Milky Way. Even the new star which was observed in August, 1885, in the great nebula in Andromeda forms no exception, for in Dr. Boeddicker's beautiful drawing of the galaxy, which has just been published, a faint extension of nebulous light is shown stretching from Cassiopeia's Chair to the nebula referred to.

A better example of a true temporary star is that which appeared in November, 1876, near Rho Cygni. It was first seen by Schmidt at Athens, soon after sunset, on the evening of November 24th, when it was about the third magnitude, and slightly brighter than Eta Pegasi. The appearance of this object was also probably sudden, for between November 1st and 20th Schmidt observed the vicinity, and was certain that no star of even the fifth magnitude could have escaped detection. Between November 20th and 24th the sky was, unfortunately, cloudy, so that the exact time of its appearance is unknown. This star was quite new, as it does not appear in any star-chart or catalogue. Like most of these curious objects, its light faded very rapidly. In the forty-eight hours following the night of November 27th it diminished to the extent of one and a half magnitude, and on November 30th it was reduced to the fifth magnitude. It afterward decreased with tolerable regularity, and in September, 1877, it was below the tenth magnitude. In subsequent years it became very faint. Ward found the star only sixteenth magnitude in October, 1881, and it was estimated of the fifteenth magnitude, at Mr. Wigglesworth's Observatory, in September, 1885. It was examined with the spectroscope a few days after its discovery, and its spectrum showed bright lines similar to the star in Corona Borealis. Subsequent observations seem to show that this extraordinary object changed into a small planetary nebula!

The star which appeared in August, 1885, in the great nebula in Andromeda (31 Messier) has been already referred to. It seems to have been independently noticed by several observers toward the end of August. It was, however, certainly seen by Mr. T. W. Ward, of Belfast, on August 19th, at 11 P. M., when he estimated it at nine and a half magnitude. On September 3d the star was observed at seven and a half magnitude, at Dunecht, by Lord Crawford and Dr. Copeland, and its spectrum was found to be "fairly continuous." The star gradually faded away, and on February 7, 1886, was estimated only sixteenth magnitude with the twenty-six-inch refractor of the Naval Observatory at Washington. Dr. Auwers has pointed out the similarity between this outburst and the star of 1860 in the cluster 80 Messier, and thinks it very probable that both phenomena were due to physical changes in the nebulæ in which they occurred.

The most recent example of a new star is one discovered by Mr. T. D. Anderson, of Edinburgh, in the last week of January in the present year, and still visible with an opera-glass. It lies about two degrees south of the star Chi Aurigæ, in the Milky Way, and when first noticed was about magnitude four and a half. The star seems to have been visible for some time previously, as it has been found that its spectrum was photographed at Harvard Observatory, U. S. A., on December 1st, 10th, and 20th, before it was recognized as a new star. The actual time of its appearance therefore remains unknown, but that it is a new star there can be no doubt, as it does not appear in any star-chart or catalogue. The star is a very interesting object, and, according to observations by the present writer, is subject to sudden changes of brightness. It seems to be fading slowly, and on March 1st was still somewhat brighter than the sixth magnitude.* Its spectrum is a very remarkable one, showing, it is thought, both bright and dark lines. The line C and other lines in the red are visible, the D line of sodium and the series of hydrogen lines being also present. Most of the lines are said to be double, each consisting of a bright and dark component. These double lines suggest the presence of two bodies, or systems of bodies, one approaching the eye and the other receding from it, with a relative velocity of between five hundred and six hundred miles per second. There is a suspicion that the bright lines characteristic of nebular spectra are also visible. These remarkable results suggest that the light of this star, and probably that of all "temporary" stars, is due either to the rush of a solid body through a gaseous nebula, or the clashing together of two meteoric swarms moving in opposite directions. The phenomenon might also be explained by two bodies forming a binary star passing through their perihelion, the great increase of light being due to a "violent grazing collision" at the point of nearest approach. Whether this new star is a veritable *nova*, or "temporary star," or merely represents the maximum of a hitherto unrecognized variable star of long period, like the so-called "Nova Orionis," discovered by the present writer in December, 1885, must be left to time to decide. In either case, it is a most interesting object, and its future career will be followed by astronomers with great interest.

Coming now to Class 2, we find regular variable stars with periods ranging from about 100 to 700 days, and with fluctuations in their light from about one magnitude to over eight magnitudes. Among the most remarkable of these are Mira Ceti, or the "wonderful star"; Chi Cygni, already referred to; R. Hy-

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* Further observations on March 10th and 11th showed that the star had then faded to below the seventh magnitude; and on March 16th I could no longer see it through an opera-glass.

dræ, R. Leonis, etc. Mira Ceti varies from about the second magnitude to a little below the ninth, with a mean period of about 331 days from maximum to maximum. Owing to its unusual brilliancy at maximum, and the great range of its light-fluctuations, this is perhaps the most interesting and remarkable of all the variable stars. The period of Chi Cygni is about 406 days, and its variation from about the fourth to nearly the thirteenth magnitude. R. Hydræ varies from the fourth to the eleventh mgnitude, with a period of about 437 days; and R. Leonis from about the fifth to the tenth magnitude, with a period of about 313 days. Most of the long-period variables are reddish in color, and show a banded spectrum, which seems to be a characteristic feature of this type of variable. Various theories have been proposed to account for the variation of light in long-period variables, but none of them are very satisfactory. The periodical outbreak of sun-spots on a large scale has been suggested, and also the clashing together of meteoric swarms revolving in an elongated orbit; but it must be confessed that the subject is still, to a great extent, a matter of mystery.

Class 3 includes the irregular variables—that is, stars which are undoubtedly variable, but have no regular periods. Sometimes these stars remain for long periods without any perceptible change, while at other times their fluctuations of light are very noticeable. Of these, perhaps the most remarkable are Mu Cephei (Sir William Herschel's "Garnet Star"), Alpha Herculis, Alpha Orionis (Betelgeuse), and Beta Pegasi. The variation is usually small, not exceeding one magnitude. Like the regular variables, these have also banded spectra.

In Class 4 are some very interesting objects—variable stars of short period. The greater number of these have periods of under eight days. The variation of light is generally small, but regular. In but few cases does it much exceed one magnitude, and in several it is less. In some, as in Beta Lyræ, Zeta Geminorum, and Eta Aquilæ, all the light-changes may be observed with the naked eye, while in others an opera-glass is necessary to follow the fluctuations.

In Class 5 are placed stars of the Algol type. These are the rarest of the regular variables, only ten having been hitherto detected. In these stars the light remains constant, or nearly so, for the greater portion of the period. A sudden diminution of brightness then commences, and all the light-changes are completed in the course of a few hours, after which the star returns to its normal brightness. The brightest of these remarkable stars are Algol (Beta Persei), Lambda Tauri, and Delta Libræ. The others are much fainter, only two being visible to the naked eye when at their normal brightness. A star of this class recently discovered in the Southern Constellation (Antlia) has the surprisingly short period of only seven and three quarters hours—the most rapid variation hitherto detected in any variable star. All the Algol variables are white, or only slightly colored.

It was long since suggested that the periodical diminution of light in the Algol variables might possibly be due to the interposition of a dark, eclipsing satellite. Some few years since Prof. Pickering undertook a mathematical investigation of the case of Algol, and showed that an eclipsing satellite revolving in a nearly circular orbit in a period indicated by the light-variations of the star would satisfactorily explain the observed phenomenon within the limits of errors of observation, and he suggested that the orbit might be determined by spectroscopic observation of the star's light before and after the minimum. Observations of this kind made by Prof. Vogel at Potsdam, in 1888 and 1889, leave little doubt that the decrease of light is really due to an eclipsing satellite. He found that before the minimum the bright star is receding from the earth (and therefore the dark companion approaching), and after minimum it is approaching, thus proving the eclipse theory to be correct.

Herr J. Plassmann, of Warendorf, Germany, has lately announced his discovery of a secondary minimum in the light of Algol and Lambda Tauri. This, if confirmed, would seem to show that the eclipsing satellite is not absolutely dark, but possesses some inherent light of its own, this light being cut off when the satellite passes in its turn *behind* the disk of its primary.—*The Gentleman's Magazine.*

An extensive human settlement, belonging to the stone age, has been discovered near Schaffhausen, Switzerland, by Dr. Ruesch, and is being laid bare under his supervision. It is in a rocky niche, about thirteen metres high and thirty-seven metres long, and is the first of that period that has been discovered in Switzerland which is not connected with a cavern. The overhanging rocks offered a roof as protection against the weather. Quantities of flint knives, chisels, and lance-heads, bones of the reindeer, roe, stag, hare, cave-bear, and other animals, and human bones, needles, and the beginnings of drawings, were also found here.

A suggestion was made in Ciel et Terre, some time ago, that the date be regularly noted, as a climatological fact, of the day, for each place on which certain agricultural operations, particularly in harvesting, are begun. As the ripening of the crops depends on the absolute amount of heat they have received during the season, the date of beginning the harvest will determine when the amount of heat required by each plant has been accumulated. Father Cl. Buvé, curé of Linsmeau, Belgium, suggests that the measurement of the amount of beet-sugar produced from a given quantity of beets will serve the same end; for, other things being equal, it is entirely dependent on meteorological conditions.

THE WASTE AND GAIN OF THE DRY LAND.

THE following letter, respecting a former article in the Monthly, has been addressed to the Editor:

Editor Popular Science Monthly:

Does M. A. de L'Apparent's interesting address * on The Future of the Dry Land exhaust all the factors of the inquiry? Is it certain, for example, that some at least of the greatest mountain-chains have not in the main risen in elevation faster than the eroding agencies have depressed them? Are not some of them, and those now among the boldest, admitted to have been uplifted in comparatively recent times, geologically speaking—more recently, for example, than the advent of some of the rivers which intersect them? Erosion must have commenced from the very beginning of the upheaval and have continued to the present time; yet they grew in stature in spite of it, for no one now supposes that the upheaval was a sudden one. Indeed, the persistence of the river's "right of way" proves both the constant action of "the elements" and the extremely gradual character of the upheaval. If our planet, as some think, continues to slowly contract from a once nebulous condition, its advancing age might be expected to be marked by wrinkles, just as we know it to be.

Again, is there not good ground for the conjecture that our globe, however slowly, is approaching a state of desiccation such as is manifested partially in our neighbor Mars and still more notably in the moon? † Is there not some lingering continuance of the once active absorption? Is there not, for example, reason to believe that the proportion of sea area has in the main steadily diminished and that upheaval of the land masses has steadily increased since Silurian times?

To the lay reader this masterful and interesting paper of the French *savant* seems a courteous invitation to one of his compeers to take up the thread of his discourse at the point at which he elects to leave it. GEORGE HENRY KNIGHT.

TEMPLE COURT, NEW YORK.

Other letters on this subject have been received, all of which indicate that the matter has attracted more interest than was anticipated. Our correspondents may find on closer examination of M. de L'Apparent's paper that he avowedly presents it as covering only one side of the question, and that, while he does not discuss

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* Popular Science Monthly, June, 1891.

† Do not northern Africa and western Asia contain vast regions that have passed from exuberant fertility to hopeless aridity even during the historical period?—G. H. K.

the compensating forces, he recognizes their existence and their title to be considered. If we understand him aright, his article was designed to be tentative, and as opening the way to a discussion in which much may be said on both sides.

The discussion which follows will help to give more light concerning M. de L'Apparent's views and meaning and their value.

M. Jacques Léotard has written in the Revue Scientifique that M. de L'Apparent has in his evidently very curious study arrived at his result only by neglecting several factors of contrary effect.

While it is admitted that the earth is swept by powerful atmospheric agents which, if their work was continued without compensatory action on the other side, would ultimately level and submerge all the continents, M. Léotard insists that there exist other very important causes of increase of the relief, the action of which now counterbalances and may ultimately surpass that of the solvent influences.

One of these causes, of which M. de L'Apparent took some notice, is the contribution of volcanic products to the soil It is one of the most minute of the factors, but M. de L'Apparent's estimate of one sixth of a cubic kilometre a year seems too small. The three hundred known active volcanoes on the surface of the earth ought to give out a much larger quantity of their internal products; and it should be remarked that the dejections of craters, besides lavas, comprise various rocks, mud, and ashes. But the importance of this factor, little at the most, is made still less by the occurrence of volcanic explosions on the sea-coast, in which considerable tracts of land have been swallowed up.

The chief essential cause of increase of dry land at the expense of the ocean lies in the evolution of our planet. During the geological epochs of thousands of centuries each the upheavals which formed existing continents have come in gradual succession, taking from the primitive sea, which originally extended over the whole earth, a larger and larger part of its immense domain. These upheavals, under the action of internal forces, have continued slowly till our own time in many regions, notably in the north and center of the Scandinavian Peninsula, Spitzbergen, northern Siberia, Turkistan, Scotland, Sardinia, Tunis, on the coasts of the Red Sea, etc., while the depressions of vast countries, which must not be confounded with little local collapses produced by the subterranean work of water, are less numerous. Besides the increase of continents, new islands of volcanic origin rise at times to the surface of the seas, and lands are also gradually formed by the accumulation of sedimentary matter and organic remains. The deltas which rise at the mouths of large rivers in consequence of the deposition of mud and sand transported by the streams, likewise constitute an augmentation of the emerged soil, for the space they occupy is taken from the sea. The sea, moreover, does not eat away all the shores. There are coasts where the waves, instead of carrying away parcels of the dry land, operate to fill up the bays and to add to the littoral and prolong it in the direction of the sea. Thus the ocean every year deposits several million cubic metres of sand along the shores of the Gulf of Gascony.

Another accrement which has a right to be regarded as considerable is contributed by the legions of polyps constructing reefs and atolls of coral, to which is due the building up of whole archipelagoes in Oceania and the Indian seas. The islands formed by these minute zoöphytes are growing continually in extent and number, and are probably destined ultimately, by joining, to give rise to vast lands, real continents, which will gradually occupy the immense voids of the Pacific.

The shells of numerous species of animals and other remains of dead organisms, meteorites and cosmic dusts falling from celestial space, certainly produce further sensible augmentations of the continental mass.

Another essential cause of increase of dry land that might be added is the decrease of the ocean itself in consequence of infiltrations of water through the crust of the earth, which is a kind of porous mass, into which the liquid element percolates by innumerable fissures, taking possession of the depths and directing itself slowly toward the center, as the internal fire diminishes and the crusts crack open in consequence. It is understood that the activity of volcanoes and many earthquakes is largely due to this inevitable penetration of the water, which internal heat transforms into vapor under pressure. Some geologists think that the primitive ocean has already diminished in this way one fiftieth of its volume.

The water is all destined to disappear from the surface of the globe by being absorbed by the subterranean rocks, with which it will form chemical combinations. The heavenly spheres exhibit sufficiently striking examples of such an evolution. The planet Mars shows what will become of the earth in some thousands of centuries. Its seas are only shallow Mediterraneans of less surface than the continents, and these do not appear to be very high; and in the appearance of the moon, all cracked and dried up, we have a view of the final state of the earth—for the absorption of the water by the solid nucleus will be followed by that of the atmosphere.

We see, therefore, M. Léotard continues, that not only is there no equilibrium in the struggle between the oceans and the continents, but that, inversely to the conclusions of M. de L'Apparent, the event that may be considered very probable in a future represented by millions of years will be, not the disappearance of the dry land, but that of the sea, which, accompanied by all the fluids, will gradually infiltrate through the crust with which our planet is covered.

The certain feature in M. de L'Apparent's essay is that, before the eternal drought comes on, the terrestrial relief will be leveled. The continental surface will have become an immense plain, in which the Alps, Himalayas, and Andes will be only little hills. The fertility of the soil will be augmented by the considerable formation of vegetable earth, which will at the same time be deprived of sufficient watering by the rarity of rain. Climates, little as we may suppose them to be modified by the decrease of the luminous and calorific energy of the sun, will be entirely transformed. It seems to M. Léotard, in short, that the phenomena contributing to the destruction of the continents will diminish continuously in intensity, while the natural influences tending to result in the desiccation of the surface of the globe will gather energy in the course of ages, preparing for our planet the curious future just described—a future which will, however, be postponed so far that mankind will not be a witness of that end of terrestrial evolution.

Another writer in the Revue Scientifique (H. S.) has called attention to what the land is gaining, believing, in view of the universal stability of affairs, that it must be equal to the losses. The land gains everything, including cosmic dust and meteorites, that falls from space; it gains all the gases that are continually undergoing solidification in flesh and wood, with which they become incorporated; and it gains the shells of all the molluscs, infusoria, etc. With a very insignificant part of what these infinitely small beings have left it has been possible to build cities larger than Paris; and the Great Pyramid may be said to be the work, not of King Cheops, but of the nummulites. If a well-informed person should follow out all the facts bearing on the subject, he would probably find a complete equilibrium, an admirable compensation existing between the gains and the losses of the crust of the earth.

M. de L'Apparent has replied to M. Léotard's criticism that it rests on a misunderstanding which can be easily dissipated. In the summer of 1890, he says, "I discussed, in the Geological Society of France, the general question of erosion, not to predict the actual leveling down of the dry land, but simply to arrive at a method of estimating the duration of the geological periods. My reasoning was as follows: If the present causes of destruction (mechanical and chemical action of running waters and marine erosion) continue to act in the same measure as now, without anything intervening to disturb their working, the continental relief will wholly disappear in four or five million years. Geology teaches us that the history of the crust of the earth embraces a period infinitely longer than this. That is enough to prove that another factor does intervene—that is, manifestations of internal energy, which disturb from time to time the acquired states of equilibrium, and restore a new force to the decreasing outer powers. Thus, instead of assuming a regular process of planing down, I laid down in principle that things would not go on in this way. A geologist, besides, could not reason otherwise, except he mistook the daily teachings of science which show him at every instant foldings and contortions of strata, certain signs of an order of things very different from the regular pursuit of external influences.

"Seeking, then, to place myself under the most unfavorable conditions for my theory, I supposed the ancient history of the globe divided into tranquil periods, each of four or five million years, separated from one another by so many ruptures of equilibrium. How many of these periods would be required to account for all the known sedimentary formations? In trying to solve this problem, I remarked that each period would have cast into the ocean a cube of *débris* which, scattered, according to Mr. J. Murray, through only one fifth of its area (the fraction over which, according to the soundings, the sedimentation of detritus extends), would form a bed of some six or seven hundred metres in mean thickness. It seemed to me reasonable to suppose that this thickness, null at the extreme further side of the deposits, would increase slowly at first, and then more rapidly toward the neighborhood of the coast, where it might attain a maximum of two kilometres. Dana having estimated at forty-five thousand metres the united depth of all the sedimentary formations when each is measured at its point of greatest thickness, I drew the conclusion that all geological history could be included within a time certainly less than ninety million years. After the publication of this note I was called upon by the general secretary of the Geographical Society to supply the place of a speaker who was unable to fulfill his engagement. I responded, undertaking to call the attention to the phenomena of erosion which I had been studying, without elaborating the purely geological considerations. I have recently presented an extended paper on these details to the Catholic International Scientific Congress, and in it have examined all the phases of the question. This paper will be published in full, and in it M. Léotard will be able to learn how greatly my views differ from those which he has mistakenly attributed to me.

"I will here only correct a grave error which my critic commits when he charges me with not having taken account of the accrement which volcanic action brings to the dry land. M. Léotard forgets that all the lava that flows to the surface comes from the depths of the crust, where its departure leaves a void which can be compensated for only by the depression of the adjoining territory to such an extent that the emerged relief really gains nothing. More than this—volcanic action, which M. Léotard would make creative, is really, above everything else, destructive. I ask no better proof of this than the great explosions of which the nineteenth century has been the witness; that of 1845, at Temboro, which covered the neighboring country and the surface of the sea with a mass of *débris* estimated at a hundred cubic kilometres; and the more recent eruption at Krakatoa, which threw into the Strait of Sunda eighteen cubic kilometres of *débris* and formed an abyss between two and three hundred metres deep, in a place where there had previously stood a volcanic mountain several hundred metres high. While I have felt called upon to make this rectification, I will add that that does not prevent me from believing, with M. Léotard, that the final triumph of the dry land is infinitely more probable than its submersion; and that by reason of the considerable movements of the crust and the wrinkles which lateral compression in consequence of the progress of cooling can not fail to engender from time to time."

SKETCH OF LUIGI GALVANI.

THE experiments of Galvani were the beginning of a new course of development in physical science, the fruits of which promise to be infinite in number and of incalculable magnitude and importance.

Luigi Galvani was born in Bologna, Italy, September 9, 1737, and died in the same place, December 4, 1798. He exhibited when very young a fervent zeal for the Catholic religion, of which he was exact in observing the most minute rites. He even thought of going into a monastery, but was diverted from his intention, and, while his religious inclinations were still prominently marked, he became interested in scientific pursuits. Entering upon the study of medicine, he gave his attention chiefly to anatomy and physiology—human and comparative. Having successfully maintained a thesis on the Bones, their Nature and Formation, he was appointed, in 1762, public lecturer on anatomy at the University of Bologna, where he became known as a skillful and accurate teacher, though not eloquent in address. Along with his professorship he gained high repute as a surgeon and childbed doctor. He produced during the earlier period of his professional career a number of memoirs of considerable merit, among the most important of which were those on the urinary organs and kidneys of birds and on the ears of birds. In the former paper he treated the subject with remarkable accuracy, showing the position of the kidneys of birds in the abdomen, their situation with respect to the vertebral column, and how they are adapted, as in quadrupeds, to the secretion of urine. The descriptions, all drawn with equal care, contained various curious facts, some of which had then the merit of novelty. Three years after this Galvani had prepared a large work embodying the fruits of his studies of the organ of hearing, when he was anticipated by the publication of Scarpa's Observations on the Fenestra Rotunda. He was astonished to find in this book the facts which he had announced at special sessions of the institute, and which he had believed to be his own exclusively, and, giving up the publication of the larger book, satisfied himself with imparting in a short sketch such facts as were not mentioned in Scarpa's treatise. He gave interesting details respecting the chord of the tympanum, the membranous labyrinth, the semicircular canals, and on the single little bone which in its own body and appendices performed the functions of the three little bones found in the ears of mammals. His most important work, the one on which his enduring fame is based, was published in 1791, under the title De Viribus Electricitatis in Motu Musculari Commentarius, or Commentary on the Forces of Electricity in Muscular Motion. It embodied, in a small volume of only fifty-five pages, the account of his experiments with the frog's leg, in which the kind of electrical manifestation to which Galvani's name is attached (galvanism) was first remarked by him.

Previous to the publication of this little book Galvani suffered his greatest grief by the death of his wife, Lucie Galeazzi, with whom he had lived happily for thirty years, and who, according to some of the versions of the story, had no little to do with his great discovery. This loss was followed by other troubles, which, although they did not so nearly touch his heart, were severe enough, and eventually perhaps hastened his death. The Cisalpine Republic required an oath from all persons in its service, which, it being repugnant to his political and religious convictions, Galvani refused to take. The Government deprived him of his position, and he, nearly reduced to poverty, went to live with his brother Giacomo. Soon afterward he fell into a decline, from which he could not be raised even by the skill and careful attention of the eminent physicians Uttini and Cingari. The Government of the republic, recognizing the eminent worth of his scientific achievements, notwithstanding he persisted in refusing to take the oath, ordered him restored to his chair in the university, but he never took advantage of the act.

Various stories are told of the manner in which Galvani's discovery of galvanic action, or "animal electricity," as he called it, was brought about. According to one version, he was preparing a frog-broth for his invalid wife, and some skinned frogs were lying on a table by the side of an electrical machine. One of his assistants accidentally touched the crural nerve of one of the frogs with the point of a scalpel, when all the muscles of the limbs seemed to be taken with strong spasms. Madame Galvani, a bright, thoughtful woman, who was present and witnessed the shock, was struck with the novelty of the phenomenon, and thought that she noticed along with it a disengagement of the electric spark. She informed her husband at once, and he lost no time in verifying the extraordinary fact. The point of the scalpel being again applied to the frog, while a spark was drawn from the machine, the contractions were resumed. To determine whether they were not due to the simple contact of the scalpel, Galvani touched the same nerves of other frogs without turning the machine, and got no contractions. Repetitions of the experiments were accompanied with corresponding results. Another account makes Galvani himself the chief actor in the incident; while, according to a third account, Galvani, having dissected some frogs, in a study of their nervous system, hung them on an iron railing with a copper hook thrust in their lumbar nerves, and the contractions took place whenever, in the vibration of the specimens, these nerves touched the iron too. According to the documents in the possession of the Museum of Bologna, the discovery was not all a matter of accident, as these stories would make it appear, for it is shown there that Galvani had been engaged, for twenty years before the publication of his Commentary, in investigations of the action of electricity on the muscles of frogs. The thought involved in these experiments had also been more or less vaguely suggested by other writers. Sulzer, in his Nouvelle Théorie du Plaisir, published in 1767, had spoken of the peculiar taste produced when two pieces of different metals were put, under certain precautions, into the mouth. A pupil of Cotugno, Professor of Medicine at Naples, in dissecting a mouse about 1786, perceived a movement at the moment when his scalpel touched one of the animal's nerves. Galvani described his experiments, and claimed that he had discovered a kind of electricity having remarkable peculiarities, in the Commentary (De Viribus Electricitatis in Motu Musculari) already mentioned, which was published in 1791 and 1792. One of the immediate results of his discovery was the invention of his metallic arc, the first experiment with which is described in the third part of the Commentary, with the date September 20, 1786. This arc was constructed of two different metals, which, placed in contact, one with a nerve and the other with a muscle of a frog, caused contraction of the muscle.

Galvani recognized a great similarity between the phenomena he had observed and electricity, but denied their identity. He thought an electricity of a peculiar nature was concerned in the manifestations, and that he had discovered the nervous fluid. In his view, all animals possessed an electricity inherent in their economy, which resided especially in the nerves, and was communicated by them to the whole body. It was secreted by the brain; the interior substance of the nerves was endowed with a conducting power for this electricity, and facilitated its movement and its passage through the nerves; at the same time an oily coating of these organs prevented the dissipation of the fluid and facilitated its accumulation. The principal reservoirs of this electricity he supposed to be in the muscles, each fiber of them representing a small Leyden jar, from which the nerves were conductors. In the mechanism of the movements the electric fluid was drawn out and attracted from the interior of the muscles into the nerves in such a way that each discharge of the muscular electric jar corresponded with a contraction of the muscle. This theory had many partisans for a considerable time, but was refuted by Volta, who showed, as has been related in our recent sketch of him, that the supposed nervous fluid was only ordinary electricity, to which the animal organs served as conductors, and of which they might even be generators. Galvani did not yield to these arguments of Volta's, but held to his own unsound hypothesis; and thus the glory of making a scientific explanation and application of his great discovery fell to Volta. An account of Galvani's discoveries was published in the Philosophical Transactions for 1793. A quarto edition of his works was published at Bologna by the Academy of Sciences of the Institute of that city in 1841–'42. Perhaps the best and most appreciative accounts of Galvani's life and works are by M. Arago, in Alexandre Volta, in the first volume of Arago's Œuvres Complètes, and the eulogy by J. L. Alibert, Bologna, 1802.

Mr. A. Wilkins, of Tashkend, central Asia, had a specimen of the typical desert bird of the country (*Podoces panæri*), which, on the first day of its life with him, buried a part of the food given it in the sand with which the floor of the cage was covered. On the next day, and afterward, the bird abandoned the habit on perceiving that the supply given it did not fail. Another correspondent of Nature had a fox-terrier puppy, seven weeks old, which had not seen any other dog but its mother, that buried bones in the garden with great skill. It dug a hole with its fore paws, put in the bone, pushed it down with its nose, and covered it with garden soil which was pushed in with its nose. He had never seen so young a puppy bury bones, or any other dog do it so well.

CORRESPONDENCE.

GENESIS OF THE DIAMOND.

Editor Popular Science Monthly:

SIR: An excellent notice of Prof. A. E. Foote's paper on Diamonds in Meteorites has newly been forwarded to me, and, as it has apparently aroused no little interest in the general public as well as in scientific circles, may I take the liberty of calling attention to the following facts through the pages of The Popular Science Monthly, to which I have for some years past been a subscriber?

In September, 1886, my husband, the late Prof. H. Carvill Lewis, read before the Birmingham meeting of the British Association for the Advancement of Science a paper on A Diamantiferous Peridotite and the Genesis of the Diamond, a small specimen of which he had recently discovered, *in situ*, in a piece of the peridotite rock underlying the tenacious "blue clay" of the Kimberley mines. He further stated that this "blue clay" was found upon subsequent analysis to be merely the same peridotite rock in a high state of decomposition. The process of freeing the diamonds from the "blue clay," in which they are scattered about like plums in a pudding, is so well known that it need not be dwelt upon.

The peridotite in question is an altered lava, filling the neck of an ancient volcano, which burst its way through a rich deposit of carbonaceous shales. Numberless fragments of this shale, of varying size, were found scattered throughout the peridotite, and Prof. Lewis held that it was the pure carbon from these, which, liberated by the intense heat, and crystallizing slowly out under enormous pressure, had formed the diamonds.

In September, 1887, my husband delivered another address at the Manchester meeting of the British Association for the Advancement of Science, entitled The Matrix of the Diamond, in which he described in full the chemical changes and metamorphoses which the peridotite and its constituents had undergone in passing into the "blue clay." An abstract of this paper was distributed among the geologists present, and was afterward published in the Report of the Association for 1887.

At the close of this paper Prof. Lewis remarked that "if his hypothesis concerning the origin of diamonds was correct, they would certainly be found in meteorites"; but it was not until December of the same year (1887) that he received, through the courtesy of Mr. George Frederick Kunz, of New York, a small fragment of meteoric ore, in the larger portion of which two Russian geologists had newly reported the finding of several minute diamonds. Mr. Kunz found thirteen diamonds, I believe, in his share of the meteorite, and my husband found three; but in both cases all were microscopic. This discovery was soon after announced at the Academy of Natural Sciences in Philadelphia, and a short notice of it was published with the title Diamonds in Meteorites.

To Prof. A. E. Foote, therefore, belongs the honor of finding the first diamonds in American meteorites, and not of discovering that abstract possibility or its first realization.

The manuscript for a comprehensive article on The Origin and Matrix of the Diamond, embodying Prof. Carvill Lewis's Birmingham and Manchester addresses, and the subsequent investigations made by him as to the origin of that gem in the southeastern portion of the United States, is now in the hands of Prof. G. H. Williams, of the Johns Hopkins University, and will, it is hoped, soon be ready for the press.

In view of the foregoing statements, it seems open to question whether the position of the meteoric fragments on the side of an old volcanic crater was not an accidental one, which at all events calls for further investigation before those outside the charmed circle of scientific workers are willing to accept so remarkable a hypothesis as to the origin of our terrestrial diamonds.

I am, with respect,

Faithfully yours, JULIA F. LEWIS.

HEIDELBERG, *January* 29, 1892.

MORE ABOUT THE PENIKESE SCHOOL.

Editor Popular Science Monthly:

PRESIDENT JORDAN'S interesting article on Agassiz at Penikese forms a valuable contribution to the history of marine laboratories in this country, in giving a list, unfortunately incomplete, of those in attendance at the school during its first session. Might it not be possible to complete the list for both years during which the school was in existence? Such a list would form a valuable appendix to the interesting account of the school given by Mrs. Agassiz in her Life and Letters of Louis Agassiz.

President Jordan does not mention in his article the fact that the laboratory building no longer exists. It was destroyed by fire during last summer. A week before its destruction I visited Penikese with a small party from the Marine Biological Laboratory of Wood's Holl, Mass., and had the pleasure of meeting the present owner of the island, Mr. G. S. Horner, of New Bedford, who kindly gave us permission to carry away for the Marine Biological Laboratory anything we might find of interest or of use. We took advantage of this kind permission to detach from the walls the inscriptions which decorated the laboratory, and to which President Jordan refers. They were written on heavy paper and were in perfect preservation; they will hereafter adorn the walls of the linear descendant of the Penikese school—the Marine Biological Laboratory.

The inscriptions were not written upon the blackboard, as President Jordan states, on the authority of Prof. Eigenmann. This was occupied by some notes and drawings apparently used in illustration of a lecture on the vertebrata, said, I know not on what authority, to have been delivered by Prof. Wilder. The inscriptions themselves are not quite correctly quoted by President Jordan. They are as follows:

"Study Nature, not books."

"Learn to say, I do not know."

"A laboratory is to me a sanctuary, and I would have nothing done therein unworthy of the great Creator."

I quote these from memory, and am not quite sure as to the completeness of the second one, though what I have given contains the gist of it. It is advice which all young teachers, for whom it was primarily intended, should conscientiously heed.

Yours respectfully,

J. Playfair McMurrich.

University of Cincinnati, *April* 7, 1892.

FLOWERING HABIT OF THE AMERICAN ALOE.

Editor Popular Science Monthly.

Sir: In Grant Allen's very readable paper in the May issue—A Desert Fruit—mention is made of the American aloe (*Agave americana*) in a way to mislead as to its flowering habit. Permit me to say that the plant in question does not, as the writer says, "flower . . . once in some fifteen years or so"; *it flowers once only, and then dies.* In this city it is somewhat the exception for a summer to pass without one or more specimens of the agave throwing up an immense flower-stalk—not a spike but a *panicle*—to the height of twenty-five feet or more, with large clusters of flowers on the ends of its two- to six-foot branching pedicels; but, after the development of the flowers and ripening of the fruit, nothing remains of the previous tall rosette of fleshy leaves but a lot of withered and empty skins. And, by the way, the house-leek (*Sempervivum tectorum*), which takes several years to flower—five or six in these parts—has the same trick of dying as soon as it completes the process. It is doubtless on account of the habit which both these plants have, of multiplying by suckers or stolons, that many have overlooked their monocarpous nature, and have supposed that the new plants standing around were the same as flowered fifteen years ago.

George Pyburn.

Sacramento, Cal., *May* 1, 1892.

[We are glad to have the above particulars about the habit of the aloe, but we do not find in Mr. Allen's casual words any assertion that the same plant flowers more than once.—Editor.]

A CORRECTION.

Editor Popular Science Monthly:

Sir: On page 137 of your May number you inadvertently do a great injustice to Mr. Nicola Tesla, by styling him "the able lieutenant of Mr. Edison."

Mr. Tesla is an independent investigator, whose path has been the development of the alternating current, while Mr. Edison has followed the course of the direct current. I venture to suggest a note of correction.

Yours faithfully,

Charles Paine.

Century Club, New York, *April* 23, 1892.

EDITOR'S TABLE.

MOTHERHOOD.

MUCH advance has been made within the last generation in the matter of the education of women; but even the ambitious programmes of the present day do not make as full or as distinct provision as might be desired for instruction in the elementary duties and responsibilities of motherhood. We are very ready to allow that not every woman is called to be a mother, and we sympathize to a considerable extent with those who object to holding up marriage as the only goal at which women should aim. At the same time we incline very strongly to the opinion that the education of no woman can be complete unless it embraces the best obtainable knowledge as to how children should be brought up and trained, and as to the qualities, physical and moral, which their proper nurture and culture demand of the mother. The woman who is not called to be a mother may be called to be an aunt, and as such may have a large share in the education of children. We are not all called upon to rescue or resuscitate drowned persons; but most of us would willingly possess the knowledge necessary for such a purpose. It may be said, Why teach the duties of motherhood more than those of fatherhood? If so, the answer is, We should teach them *more* because they are more comprehensive than those of fatherhood, and because the relation between mother and child is so much closer than between father and child. But we fully recognize the necessity for teaching the duties of fatherhood also; and, when moral culture receives due attention in our schools, the duties which a father owes to his children will not be overlooked.

Meanwhile, however, let us consider the other and more important question. Surely it would be a most suitable thing to impress upon every girl of proper age the sacredness of the maternal function. How impressively might we apply to the expectation either of fatherhood or of motherhood the words, "He that hath this hope purifieth himself." What stronger argument for purity of life could be urged than that derivable from the duty of giving sound and cleanly parentage to one's offspring? Why are so many marriages unhappy? Mainly because they are entered upon without any thought of duty or responsibility, or any sense of the restraints upon individual caprice and impulse which are essential to subsequent happiness. It would not be difficult to show in a forcible manner the actual misery which ignorance or disregard of physiological laws entails not alone on the offenders but on their progeny as well. Passing to the important question of the hygiene of the nursery, there is much that could be taught on sure grounds of science; and the subject, in the hands of a competent teacher, could hardly fail to prove most interesting. What more satisfying object can there be to a normally constituted woman than a healthy, well-conditioned, intelligent child? The result of due instruction in matters pertaining to a mother's duties would be to make the mothers of the future happier in their children and the children happier in their mothers. It is science, as we more and more see, that is chiefly required in the household. It is the lessons of experience that need to be gathered, collated, sifted, systematized, and brought home to the minds of both fathers and mothers. We constantly hear of young couples who start off with theories of their own on the subject of the treatment of children, just as if there were no established principles available for their guidance. Surely this is folly: the very last matter to which wild experimentation should be applied is the bringing up of children; and we pity most sincerely the children whose parents think that it has been left for them to originate the true principles of child-education.

That thousands of children suffer from the over-indulgence of their parents and thousands more from their over-severity, does not admit of dispute. In any course of instruction such as we have hinted at a considerable place should be given to the psychology of the child, and a considerable place also to the commoner defects of parents. It is a wise mother that does not unduly stimulate the self-consciousness of her child, and thus lay the foundation for life-long habits of affectation. If clever children do not always make clever men and women, a partial reason may be found in the way they are commonly treated. They find grown-up people constantly on the watch to hear, and most industrious in repeating, their original speeches; and soon they exchange the gift of originality which consists in seeing and expressing things in an unconventional manner, for the very inferior one of making smart speeches. They are thus forced by the very admiration of their elders into taking conventional instead of unconventional views, and speaking, as it were, to the "gallery" instead of uttering spontaneous truths. Thus—

> "Shades of the prison-house begin to close
> Upon the growing boy"

or girl altogether too soon. The way to promote originality is to leave the mind as long as possible in direct and living contact with things, and, to do that, it is necessary to avoid any great appearance of interest in or astonishment at the judgments the child forms or the phrases it uses. As soon as a child begins to find its own *opinions* interesting, instead of, as before, finding *things* interesting, farewell to originality! Will any one say that, if girls were taught how the minds of children might be kept fresh, they would not value the knowledge and, when the time came, try to turn it to account? We hardly think so.

Too vigorous denunciation could scarcely be bestowed upon the fashion so many mothers have of making their children mere instruments of their own vanity. Most mothers, we imagine, even in this advanced age, regard their children as gifts from Heaven; but do they suppose that Heaven gave them children that they might turn them into preposterous human dolls, and prematurely age them with the burden of social follies? Here we see the need of a strong appeal to the mother-instinct of those who are not yet mothers, that they may be led to conceive a horror of sacrificing innocent children to the Moloch of an artificial and heartless society. What do we want—manikius, puppets, little bedizened and bemannered creatures full of social spites and rivalries, or children full of healthy impulses, pure, truthful, and loving, of whom it might conceivably be said that "of such is the kingdom of heaven"? Alas, that so many should deliberately choose the former, and these not the less but the more religiously devout members of the community!

One point on which a judicious teacher, addressing girls on the duties of motherhood, would certainly utter a caution, would be as to allowing the mere maternal instinct to run to excess and pass beyond control. The maternal instinct must be considered as having for its object the good of the child; but, like all instincts and passions, it tends to become an object to itself, and then the interest which it is meant to subserve suffers; the child is worried and hampered by the over-abundance of maternal caresses and attentions, to the injury sometimes of its regard for the mother. We are well aware that a perfectly balanced human being is more than the most careful education can be expected to produce; but that is no reason why we should not aim at a desirable and possible balance of faculties—of reason and imagination, of thoughts and emotions, of judgments and impulses. A woman who is all mother does not make the best kind of mother. Cases are not wanting in which an unrestrained excess of the maternal instinct injures the relation between husband and wife and mars the harmony of the household. All this could be illustrated by numerous and varied examples; and this is the kind of knowledge which we maintain might with great advantage be imparted to the rising generation of girls. Why should human happiness be wrecked for want of knowledge which so many could supply from their own experience, and of scientific principles which are the commonplaces of all who think? The time has surely come when motherhood should be redeemed from the automatism of blind instinct and wedded, for its own high purposes, with the force of intellect. We shall be happy if these few words should incite to thought on this most important subject, and cause attention to be paid to it in quarters where, as yet, it has been neglected.

LITERARY NOTICES.

The Discovery of America. By John Fiske. Cambridge: Houghton, Mifflin & Co. 1892. In two volumes.

Prof. Fiske opens his subject with a discussion of the question of the grade of culture reached by the inhabitants of the American continent at the time of the discovery. The gorgeous accounts given by the Spaniards of the civilization of Mexico and Peru have survived until quite recent times, not only in the popular imagination, but in the writings of sober-minded authors. Careful research has, however, dissipated these earlier conceptions of American culture and put it in the right relation to the condition of advancement reached by the Old World peoples. Prof. Fiske gives the chief credit to the clearing up of this question to the late Lewis Morgan, whose generalizations he in the main accepts. According to Mr. Morgan's classification, the three well-marked stages in culture are savagery, barbarism, and civilization, the dividing line between the first two being the invention of pottery, and that between barbarism and civilization the invention of the alphabet.

According to this classification, none of the American peoples at the time of the voyage of Columbus had reached a higher stage of culture than the middle status of barbarism. In the Old World this stage of culture was marked by the domestication of animals other than the dog, but nowhere in America outside of Peru were there any domesticated animals except the dog, and in the latter those of the Old World were unknown. The social development reached by the aboriginal American was in keeping with that in the arts. The Spaniards, with their notions of society derived from mediæval Europe, naturally interpreted the social arrangements they found in terms of their experience, but nowhere on the American continent, save in Peru, was there anything approaching a nation. The organization of the Aztecs in Mexico was similar to that of the more advanced Indians to the north—viz., that of the clan. Montezuma, whom the Spaniards mistook for a king, was simply the chief of the clan. The living was communal in structures the property of the clan, and there was no development of the idea of private property except in things purely personal. Peru had passed beyond this stage, and had acquired the position of a rudimentary empire, but in some things was less advanced than Mexico. Neither country had yet acquired the art of smelting iron, and between both and the beginnings of civilization there lay the vast tract which terminates with the invention of the phonetic alphabet.

Prof. Fiske follows his survey of the inhabitants of the American continent by a discussion of the visits of the Northmen to the American coast, and then takes up the relations of Europe with the East, which completes his survey of the subject, preliminary to the memorable voyage of Columbus. In his chapter on pre-Columbian voyages he sums up what is known of the voyages of the Northmen. Far from being mythical, these voyages were very real. These northern seamen settled Iceland, and from there spread over to Greenland, where two settlements were made which lasted for four hundred years. From these settlements voyages were made down the American coast as far south probably as Massachusetts. An attempt was made to found a settlement in Vinland, which was the name they gave to a part of the coast visited, but this came to no result, and they did nothing beyond visiting the place to cut timber. None of these voyages did anything toward altering the relations of the Eastern and Western world. The two streams of life flowed on as they had for centuries, unknown to each other. It was not until the epoch-making voyage of Columbus and those who followed after that the two worlds were brought into contact. Prof. Fiske, therefore, rightly considers that the voyages of the Northmen were in no sense anticipations of Columbus.

In order to understand the meaning of the voyage of Columbus, we must understand the economical condition of the Europe of the fifteenth century and its relation to the East—or Cathay, as it was termed. We must also, as Prof. Fiske insists, banish from our minds the modern map, and try to put ourselves in the place of the people of that time. A rich trade had for some centuries been carried on between Europe and the East, in spices, gums, and fine fabrics. Genoa and Venice were rival centers of this trade, and had each overland routes to the fabled land of the East. The traders did not actually pass from Europe to India and China, but met the Eastern traders and made exchange of products. Their knowledge of the East was therefore mostly hearsay knowledge, and, as is generally the fact in such a case, much fable was mixed with the truth. It was not until the middle of the thirteenth century that it became known in Europe that there was an ocean to the east of Cathay, and it was not until the close of the century, when Marco Polo published an account of his long sojourn in the East, that there was any definite information of these far-off countries accessible to Europeans. This Eastern trade, which had been steadily growing, had reached large proportions by the middle of the fifteenth century. But just at this juncture political events occurred which threatened its destruction by cutting off the routes heretofore used. The overthrow of the Mongols and the coming in of the native Ming dynasty in China had resulted in the exclusion of foreigners from that country. The rise of the Ottoman Empire and the conquest of Constantinople had cut off the northern route used by Genoa, and the Venetian route by way of Egypt was threatened by the same power. Men's minds, therefore, turned with ardor to the question of finding an outside route to the Indies. The significance of an ocean to the east of China began to be apprehended, and by the time of the first voyage of Columbus the European mind was ripe for projects for the finding of a water route to the Indies. Very little faith, however, was put in any scheme to find the Indies by sailing west. The hope and expectation were all in the direction of finding a route down the west coast of Africa and then east. No one had any idea of the extent of Africa, and, though many voyages were undertaken by Portugal, it was not until after the voyage of Columbus that Africa was entirely circumnavigated and an easterly route to the Indies discovered.

Prof. Fiske details very fully the struggles of Columbus to interest, first Portugal and then Spain, in his project of finding the Indies by sailing westward. The only ground upon which such an expedition could be based was the one that it would furnish a shorter route to the Indies than that which Portugal was seeking—down the west coast of Africa. Columbus calculated that the distance from the Canaries to Japan, the wonderful island kingdom to the east of Cathay, could not be much more than twenty-five hundred miles. As Prof. Fiske points out, this was a case where a little knowledge was helpful instead of dangerous. The perils of the voyage seemed great enough with this estimate of the distance; they would have been prohibitory had the real distance to Asia been known. Columbus died in the belief that he had reached land just off the Asiatic coast. He did not dream that he had landed upon a new world separated from Asia by a vast ocean. Years were to elapse before this fact should be appreciated by Europe, and the labors of many able navigators, extending through a period of two hundred years, were necessary to completely map out the vast new continent to which Columbus led the way.

Prof. Fiske, in recounting the many voyages and explorations by which the New World was brought within the domain of accurate knowledge, is very successful in grouping them so as to preserve the historical perspective. The reader appreciates the gradual growth of knowledge in Europe as successive voyages furnish new data, until at last there is the rounded out and completed whole. The text is supplemented by maps made from time to time by European cartographers, which are more vividly illustrative of the state of European ignorance than any amount of description could be.

Prof. Fiske devotes considerable space to clearing up the obscurity that surrounds the naming of the New World America. From this it appears that this name was proposed by a German cartographer for the land discovered by Americus Vespucius on his third voyage, when he was blown westward to the extreme eastern coast of South America. It was not known until long afterward that this land had any connection with that discovered by Columbus. The latter was supposed to be Asia, and the place occupied by the land visited by Americus was supposed to be open sea. It was therefore felt to be a proper thing to give to this new land, which was not Asia, the name of its discoverer. Later, when it became known that this was part of a land of continental dimensions, which extended far to the north as well as to the south, the name had become so fixed that it was applied to the entire continent.

The conquests of Mexico and Peru are given a large share of attention, and a very vivid and interesting picture is drawn by Prof. Fiske of these first considerable conflicts between the two orders of culture of the Eastern and the Western worlds.

The author closes his account of the discovery with the story of the navigators and explorers who, for two centuries after Columbus, were busy with the detailed exploration of the great American continent.

To those familiar with Prof. Fiske's writings, it is needless to say that the work is thoroughly well done. It is drawn from original sources, and, while here and there points remain to be cleared up, we have in the present volumes in graphic and vivid form the story of the great chain of events, in their true historic proportions, which won for civilization a New World.

Natural Science. Monthly. London and New York: Macmillan & Co. Price, one shilling a number.

We have the pleasure of welcoming a new scientific magazine, the first number of which appeared in England in March. It is to be primarily a record of new observations and discoveries in the field of natural history adapted to the needs of amateur investigators. "It will be our constant aim," say its conductors, "to expound and deal in a critical manner with the principal results of current research in geology and biology that appear to be of more than limited application. Original articles referring to the existing status of certain special branches of natural science, with suggestions for further development, will be a prominent feature. Periodical summaries of the latest results in the various departments are contemplated. Reviews of the more important new books will be not merely critical but also descriptive. Special attention will be given to the latest news concerning the work of all the principal societies and institutions throughout the world devoted to scientific and educational matters."

The magazine will have also a polemic tendency, for it starts with the avowed purpose of combating professionalism. "Half a century ago," it says, "scientific research was almost entirely in the hands of amateurs—independent workers, as Humboldt, Darwin, Lyell, Murchison, Hugh Miller, Waterton, and others." But a change has been wrought, mainly by the very rapidity of scientific progress. The more rigorous requirements of scientific work in recent years have operated to discourage amateurs, and hence to produce a wide gap between the scientific workers and the general public. Both science and the public have suffered in consequence; hence it is to be one of the aims of the new magazine to promote a better state of affairs.

The first number opens with a few pages of Notes and Comments, which are followed by articles dealing with Some Recent Observations upon Mimicry, by Frank E. Beddard; Deep-sea Deposits, by J. J. H. Teall (being a review of the Report on the Challenger Specimens, by John Murray and A. F. Renard); The Evolution of Fins, by A. Smith Woodward, illustrated; Some Salient Points in the Study of Mammals during 1891, by R. Lydekker, illustrated; English Lake Dwellings, by James W. Davis; Marine Snakes, by G. A. Boulenger, illustrated; The Exploration of Coral Reefs by Borings, by J. W. Gregory; Some Recent Researches on Insects and Arachnids, by G. H. Carpenter; Relationship of Sigillaria and Stigmaria, by Thomas Hick; and The Mammals of India, by R. Lydekker, illustrated. There are also review, news, and obituary departments.

The Philosophical Review. Bimonthly. Edited by J. G. Schurman. Boston: Ginn & Co. $3 a year.

Cultivators of philosophy have now the promise of a well-conducted and regularly appearing magazine devoted to metaphysics and the allied subjects—psychology, logic, and æsthetics. Its prospectus announces that the review "will be an open forum alike for those who increase the stock of positive data and for those who strive to see new facts in their bearings and relations, and to trace them up to their ultimate speculative implications. An equal hearing will be given to both sides of every unsettled question. The attitude of the review is nonpartisan. Writers alone will be responsible for their articles, which in all cases must be signed." The initial number of this review opens with a paper on The Critical Philosophy and Idealism, by Prof. John Watson, of Queen's University, taking Caird's work on Kant as a starting-point. Prof. George T. Ladd follows with a review of James's Principles of Psychology, under the title Psychology as So-called "Natural Science"; and Benjamin I. Gilman contributes the first part of an essay on Psychological Aspects of the Chinese Musical System, with extended examples. There is a carefully edited department of Reviews of Books, and another department in which are given summaries of articles on philosophical topics in other periodicals.

The Journal of Comparative Neurology. Quarterly. Edited by Prof. C. L. Herrick. Cincinnati: Robert Clarke & Co. $3 a year.

Prof. Herrick has undertaken the publication of a periodical which shall make known the results of researches upon the nervous systems of man and the lower animals. The two numbers now before us contain contributions to the Comparative Morphology of the Central Nervous System, by the editor, and Morphology of the Avian Brain, by C. H. Turner, both papers being continued, accompanied by plates. There is also a contribution dealing with Recent Investigations on the Structure and Relations of the Optic Thalami, by Henry R. Pemberton. The other matter in the numbers consists of notes on laboratory technique, editorials, and literary notices. In addition to the physiological topics treated in the journal, the editor intends to give increasing attention to the problems of comparative psychology.

A Guide to Electric Lighting. By S. R. Bottone. London and New York: Macmillan & Co., 1892. Pp. 189. Price, 75 cents.

This little manual essays to give in concise form the information necessary to acquaint the non-scientific reader with the principles of electric lighting. The author first treats of the electric battery, and then of the dynamo as a source of the electric current, and explains the meaning of series and multiple arc distribution. A chapter is given to lamps, arc, incandescent, and the now obsolete form known as semi-incandescent, or incandescence in the open air. In the arc lamps figured and described the only one in extensive commercial use is the Brush, of which there is a diagrammatic sketch. As the book is designed as a guide to householders and amateurs, and is not meant to be historical, the description of apparatus that have ceased to have a commercial place does not seem to be called for, and only serves to confuse the reader by presenting a multiplicity of appliances. This remark applies as well to the storage battery as to obsolete forms of lamp. Whatever the possibilities of the storage battery for power uses, it has no place in electric lighting, and there is but little probability that it ever will have. A chapter is devoted to fittings, in which is included a brief description of voltmeters and ammeters, and also one to the electric motor. Mr. Bottone seems to have but little conception of the predominating position which is being taken by alternating-current distribution, to which he gives but a couple of pages, which contain little information. The subject of meters is treated very cursorily. This would seem to be a subject of especial interest to the consumer, and a full description of the principles involved and somewhat detailed descriptions of the meters actually employed in commercial work might properly find a place in a book of this kind.

Of the volume as a whole very little can be said in commendation. It is too brief to be of much use to one wholly unacquainted with the subject, and the salient features which would be of importance and interest to the householder are not brought out with sufficient clearness. The book is printed on good paper, in clear type, but the cuts, with a few exceptions, are wretched.

The Three Circuits. A Study of the Primary Forces. By Taylor Flick. Published by the author. Washington, D. C., 1892. Pp. 268. Price, $1.50.

This is one of those pseudo-contributions to science which make their appearance once in a while, written by men who, without any thorough grasp of the fundamental conceptions of modern physics, undertake to remodel our views of molecular and planetary forces. The domain of elemental forces is sufficiently vague and obscure to give scope to attempts of this character, and not a few essays have therefore been made into it by men ill fitted to add anything of a useful character to our current conceptions.

The author's thesis is that all worlds as well as the ultimate particles of matter are magnets, and that the planetary and stellar motions are the expressions of magnetic attractions and repulsions. According to his idea, light and heat are not transmitted from the sun, but are formed in our atmosphere by the interaction of magnetic forces. The author has some good ideas, and in some things he is in line with the most advanced views of modern physics, but what is good is so mixed up with a lot of insufferable rubbish that it is nearly if not quite impossible to disentangle the two. The book as a serious philosophical work is greatly marred by the flippant style of treatment and the introduction of a hypothetical personage from whom the author derives the views he offers.

University Extension. A Monthly Journal devoted to the Interests of Popular Education. Philadelphia: J. Haseltine Shinn. $1.50 a year.

The first number of this magazine appeared in July, 1891, and already, before its first volume is complete, its circulation has become so large as to warrant a reduction to half the original subscription price. The contents of the numbers so far issued consist of outlines and suggestions for carrying on the new and popular form of educational work to which the magazine is devoted, with accounts of what has been done at the various centers for this work. In the number for April are articles on Class Work in University Extension, Extension Teaching in Wisconsin, University Extension Work in Mathematics, and An Unknown Quantity and One Possible Value. The last article advocates an extension of our free high-school system by means of evening sessions, so as to bridge the gap between the elementary schools and the university-extension work. The magazine is conducted by the American Society for the Extension of University Teaching, in Philadelphia.

G. Masson, of Paris, has begun the publication of the *Encyclopédie Scientifique des Aide-mémoire*, or Memory-help Scientific Encyclopædia, the volumes of which are prepared under the direction of M. H. Leauté, member of the Institute of France. While the publication is expected to be marked by a practical character, it will at the same time be truly scientific. It will be composed of eight hundred volumes in small octavo, which are expected to cover the entire domain of the applied sciences. Each of the volumes will be by an author who is an authority, and will give in a condensed form the precise present condition of science on its special subject and of the practical conditions relating to it. The eight volumes which were to have appeared on the first of April include works on Chronic Delirium, by Dr. Magnan; Gynæcology, by M. A. Auvard; Transmission of Force by Compressed or Rarefied Air, by M. Al. Gouilly; A Calorimetric Study of the Steam-Engine, by M. V. Dwelshauvers Dery; Disease of the Respiratory Organs, by Dr. Faisans; Electrophysiology, by Dr. G. Weiss; Distribution of Electricity by Isolated Installations, by M. R. V. Picou; and Resistance of Materials, by M. Duquesnay.

A book by *Julian Ralph*, entitled *Along the Bowstring*, is a guide-book to the south shore of Lake Superior. The Bowstring which gives it its name is the Duluth, South Shore and Atlantic Railroad, which runs (on the map) in a marvelously exact straight line from Sault St. Marie to Duluth. Special descriptions are given of Marquette and Presque Isle and of Mackinaw; and Dr. M. E. Wadsworth contributes an interesting scientific chapter on the Geology of the Marquette and Keweenan Districts. Published by the Duluth, South Shore and Atlantic Railroad.

How to reduce your Weight, or Increase it, a vivacious monograph by Celia Logan, chatty and personal while intended also to be practical, is defined as "an exposition of the Salisbury plan." Its purpose, as outlined by the author, is to make plain to every one how an easy and sure deliverance from the burden of corpulence is in his own hands; and, incidentally, to point out a way by which the meager may, readily and agreeably, attain a pleasing roundness of outline. The author professes herself to have used her prescription with advantage. William A. Kellogg, publisher, 1023 Sixth Avenue, New York. Price, 50 cents.

Notes on Beauty, Vigor, and Development, published by Fowler & Wells Co., is a booklet of practical directions for acquiring plumpness of form, strength of limb, and beauty of complexion, with rules for diet and bathing, and a series of improved physical exercises, based on the text of William Milo, of London. It gives much sound and interesting hygienic lore for ten cents.

The *President's Annual Report of Columbia College for 1891* presents a record of a very full year of changes and progress incident to a lively growth. The College of Physicians and Surgeons, which has been affiliated since 1860, is now fully consolidated as a part of the institution. An important addition to the faculty is the institution of the Da Costa Professorship of Biology, with Prof. H. F. Osborn as its incumbent, and Dr. Bashford Dean as instructor. Prof. Osborn has been appointed Curator of Mammalian Paleontology in the American Museum of Natural History, and the first important step has been taken toward co-operation of that institution and the college. Another movement in the direction of co-operation has been made in the arrangement with the Union Theological Seminary for interchange of privileges. The Law School has been reorganized, with a new course of three years, and a new chair of International Law and Diplomacy. The Department of English has also been reorganized, and a Department of Literature created, with Mr. George E. Woodberry as professor. The faculty of philosophy, philology, and letters has been further strengthened by the creation of the chair of Experimental Psychology, with Prof. J. McK. Cattell as professor. Other changes, rather incidental than fundamental, are noticed in the report.

The *Ninth Annual Report of the Massachusetts Agricultural Experiment Station* represents that a favorable season has aided materially in a successful termination of a variety of field experiments as well as in a satisfactory general management of the farm-work. The introduction of a vegetation-house for the purpose of studying, under well-defined circumstances, the influence of special articles of plant-food on the growth and character of plants and other intricate questions of vegetable physiology, is mentioned as an important addition to the resources of the institution. The report embodies detailed accounts of feeding experiments, field experiments and observations in vegetable physiology and pathology, special work in the chemical laboratory, and meteorological observations.

The work of the *Connecticut* Experiment Station, as presented in its report, has included analyses of commercial fertilizers; testing samples of butter, oleomargarine, molasses, and vinegar; analyses of feeding stuffs; various tests and analyses of milk, cream, etc.; experiments on the continuous growth of Indian corn on the same land; tests of the relative yield, in the course of years, of potatoes from tubers of different sizes; studies of the albuminoids or proteids of the seeds of the oat, flax, and cotton; and experiments, chemical and other, on the curing of tobacco.

The *Indiana* Experiment Station has suffered some changes in the personality of its staff, but its efficiency has not been impaired thereby. A study has been made for several years bearing upon the suitability of Indiana as a sugar-beet producing State, with encouraging results under certain conditions and in certain parts of the State. Investigations are in progress on the application of nitrogenous fertilizers to wheat. The plant diseases of grain, smut, a bacterial affection of the sugar-beet, and maladies of carnations have been studied. The lumpy jaw of cattle is under investigation. The feeding experiments relate to the influence of the physical condition of the rough food on meat production in steers; comparative rations of whole and skim milk for calves; different forms of feeding corn, and rations designed for producing lean or fat meat in pigs.

The *Nebraska* experiment station is gradually becoming recognized as an important factor in the agriculture of the State. The number of farmers who turn to the office for information is rapidly increasing; and the demand for the bulletins, which go regularly into the hands of more than five thousand actual farmers, is very great. The bright promise of the beet-sugar industry has led to giving it prominence in the shaping of investigations and in the report. Besides accounts of field experiments and meteorological observations, the report also contains a catalogue of the native trees and shrubs of Nebraska and "farm-notes" on many subjects.

The report of *S. A. Forbes*, State Entomologist of Illinois, *On the Noxious and Beneficial Insects of the State for 1889 and 1890*, mentions as among the most noteworthy events of the entomological record the almost complete disappearance of the worst outbreak known of the chinch-bug, the very destructive development of the grain-louse, and the appearance of the European fruit-bark beetle, which is injurious to stone fruits. Besides these insects the report contains papers on experiments with arsenical poisonings, the American plum-borer, the common white grubs, the Hessian fly, the corn-root aphis, and diseases of the larger corn-root worm and the chinch-bug. An appendix to the report comprises an analytical list of the entomological writings of William Le Barron, second State Entomologist of Illinois.

Good Roads is a new illustrated monthly magazine devoted to the improvement of the public roads and streets, edited by *Isaac B. Potter*, and published by the League Roads Improvement Bureau. Its general aim will be to stimulate the interest of the public concerning the advantages of good roads and streets, and the best methods of constructing and maintaining them; and it is intended to make the magazine of interest and value to every person who travels the common roads. It will give news of all events bearing on the improvement of roads, and a series of articles on leading subjects pertaining to it. The four numbers of the journal before us conform to the standard set up in announcing these purposes.

An account of *The Fourth International Prison Congress* has been prepared by the Hon. C. D. Randall, at the request of the Commissioner of Education, at whose office it is published, in Washington. Besides the proceedings and addresses at the Congress last held, a summary of the proceedings and results of the three previous International Congresses is presented. In the appendix are further given an account of the entertainments and excursions tendered to the Congress, papers with reference to John Howard, an abstract of a conference of the managers of the reformatory and industrial institutions of Great Britain, and information concerning Russian and Siberian prisons.

"Brochure" 2, Volume I, of the *Proceedings of the Rochester Academy of Science* contains a variety of papers, among which are botanical, geological, and zoölogical section reports; special geological and archæological articles; a list of the indigenous ferns in the vicinity of Rochester; notes on aboriginal implements recently found in Irondequoit; Peru, its people, productions, and physical characteristics; the Grand Cañon of the Colorado; the Economic Minerals of the Ancients; Cetaceans, etc.

The American Journal of Morphology, Volume V, No. 3, C. O. Whitman and E. P. Allis editors, contains papers on the Osteology of Mesohippus and Leptomeryx, with Observations on the Modes and Factors of Evolution in the Mammalia, by W. B. Scott; The Growth and Metamorphosis of Tornaria, by T. H. Morgan; A Human Embryo Twenty-six Days Old, by F. Mall; On the Precocious Segregation of the Sex Cells in Micrometrus Aggregatus, Gibbons, by Carl H. Eigenmann; Some Points in the Development of the Toad-Fish (Batrachus Tau), by Cornelia M. Clapp; Development of the Epiphysis in Coregonus Albus, by Charles Hill; and Notes on the Development of some Sponges, by Henry V. Wilson. Boston: Ginn & Co.

Le Poil des Animaux et les Fourrures (The Hair of Animals and Furs) is a pendant to a work by the same author, Lacroix-Danliard, on the feathers of birds. In it the structure, form, and color of hair are considered; hairs are classified according to their origin and consistence, and uses to which they are applied, as fine hairs and downy fur; hairs that are spun, woven, carded, or combed; felting and hats; and silks, horse-hairs, and their uses in brush-making and upholstery. Further, the author describes the habitation, ways, and hunting of the animals which furnish the raw material of hair and fur; the places of production, markets, and prices; and, finally, gives some useful information concerning the parasites of hair and the means of contending against them. Paris: J. B. Baillière et Fils.

The Journal of Physiology, edited by *Michael Foster* and other eminent physiologists, among whom are four Americans, is the leading organ of original physiological investigation in the English language. The double number, 1 and 2 of Volume XIII, contains three articles with, in all, seven plates of curve tracings. The articles are on Some of the Influences which affect the Power of Voluntary Muscular Contractions, by Warren P. Lombard; The Influence of Temperature and of Endocardiac Pressure on the Heart, and particularly on the Action of the Vagus and Cardiac Sympathetic Nerves, by G. N. Stewart; and The Blood-Corpuscles of the Crustacea, together with a Suggestion as to the Origin of the Crustacean Fibrin Ferment, by W. B. Hardy. Cambridge, England: Cambridge Engraving Company. Price, 12*s.*; $5 a volume.

Humanity and Health is a monthly journal, of which we have received the first number, published by *E. A. Jennings*, M. D., at 18 Clinton Place, New York. It is devoted "to the physical, mental, moral, and spiritual health of mankind"; the just and humane treatment of all men, women, and children; the inculcation of charity, of judgment, and the spirit of forgiveness, to equal rights, the cause of the oppressed, and other objects pertaining to the welfare of mankind; and we observe that it has kind words for animals. Pp. 14. Price, 10 cents; $1 a year.

Part I, Volume XXVI, of Annals of the Astronomical Observatory of Harvard College, relates to the *Preparation and Discussion of the Draper Catalogue*, and is by Prof. E. C. Pickering. The Draper Catalogue is named from Dr. Henry Draper, who took in 1872 the first photograph of a star in which the characteristic lines are visible. The work, interrupted by his death in 1882, is now continued at the Harvard Observatory under the Henry Draper Memorial Fund which was established by his widow. The history and progress of the Memorial are described in the introduction to the present volume. The portion of Part I which follows this account gives a description and discussion of the Draper Catalogue and of the other work done with the Bache telescope from 1885 to 1889. Accounts of other divisions of the work are promised in Part II, which is yet to be published.

The second part of the twentieth volume of the Annals of the Observatory of Harvard College gives an account, by *A. Lawrence Rotch*, of the *Observations made at the Blue Hill Meteorological Observatory* in 1889—a history and description of the Observatory, with an account of its instrumental equipment and the methods of observation and reduction, having been previously given in Part I of the volume. To the tables of the year's observations are added appendixes containing observations at Boston and at Blue Hill during the five years 1886–1890, with a summary of the diurnal and annual periods at Blue Hill as shown by the tables.

The first number of the *Engineering and Mining Journal* for 1892 (January 2d) is the annual statistical number, and contains the *Mineral Statistics for 1891*. These statistics have been collected with great pains and at heavy expense, and are claimed to be the only statistics of the whole mineral industry published until the Government reports, which are not likely to appear for a year. We are further told that the highest and best known authorities in every part of the world have contributed, each in his specialty, to this record. Besides the official returns of nearly all the important minerals and metals, it gives statements of the sources of production, the occurrence of the minerals, the use and values of their products, and in many cases the stocks of metal on hand at the close of the year.

The *Elementary Algebra* of Dr. *Charles Davies* has for many years held a high place among mathematical text-books. It is so arranged as to conduct the pupil by easy and simple gradations from the arithmetical processes to the more abstract methods of analysis, and to be introductory to the best works of higher algebra. The new edition which the American Book Company now publish has been edited and brought up to date by Prof. *J. H. Van Amringe*, of Columbia College. Among its peculiar features are the expansion and simplification of the subject of factoring, with the greatest common divisor and least common multiple; the extension of evolution to embrace any root; and greater simplicity and thoroughness in the treatment of series and logarithms.

The volume *Consumption; how to Prevent it and how to Live with it*, has grown out of the preparation by the author, *N. S. Davis, Jr., M. D.*, of a series of hygienic rules for his patients, with brief explanations of the effect of their execution. The author has faith in the power of hygiene, and expresses the belief that consumption could be reduced everywhere to very moderate limits if the bodies of children and growing youths were properly developed physically, and if the hygiene of our homes, offices, and factories were more perfect than it is. In this book the accounts of the modes of action of climates, forms of exercise, kinds of labor, etc., are brought together and presented in intelligible shape. Published in Philadelphia by F. A. Davis.

The third of the Studies in History, Economics, and Public Law, published by Columbia College, is a *History of Municipal Land Ownership on Manhattan Island*, by *George Ashton Black* (Prof. E. R. A. Seligman, 50 cents). Mr. Black describes the transactions and policy of the city of New York concerning land from 1654, when, under the name of New Amsterdam, it acquired its first piece of real estate, down to the beginning of sales by the Commissioners of the Sinking Fund in 1844. Sixteen maps of parts of the city accompany the monograph.

The U. S. Artillery School at Fort Monroe, Va., has begun the publication of a quarterly magazine called the *Journal of the United States Artillery*. The first number contains articles on the motion and velocity of projectiles, our artillery organization, and the Chilian Navy. The subscription price is $2.50 a year.

The New World is a quarterly review of religion, ethics, and theology, the first number of which has been issued recently (Houghton, $3 a year). It is under the charge of an editorial board consisting of Profs. C. C. Everett and C. H. Toy, of Harvard University, President Orello Cone, of Buchtel College, and Rev. N. P. Gilman, author of The Laws of Daily Conduct, the last named being the managing editor. The prospectus states that "the new quarterly will be open to able and constructive thinkers, without regard to sectarian lines. The New World which its editors have in mind is that which is developing under the light of modern science, philosophy, criticism, and philanthropy—all of which, rightly viewed, are the friends and helpers of enduring religious faith. To positive and constructive statements of such an order of things, as distinguished from the old world of sectarianism, obscurantism, and dogmatism, the New World is pledged." Each number will contain 200 pages. In the first number the opening article is on The Evolution of Christianity, by Lyman Abbott; and other contributors are C. C. Everett, J. G. Schurman, W. R. Alger, C. H. Toy, J. E. Carpenter, T. R. Slicer, E. H. Hall, and C. B. Upton. There is a department of Book Reviews, and in future it is intended to have in each number a survey of current periodical literature on religious subjects. The New World frankly admits the influence which the doctrine of evolution and the scientific method of research are exerting in the field of religion, and promises well to become a force that shall carry this influence onward to a more perfect freedom and to an unrestricted acceptance of the truth.

The poems by *H. L. Gordon*, in the handsome volume entitled *The Feast of the Virgins and other Poems*, having been printed for the author's friends rather than for the public, are hardly subjects for criticism. They were for the most part composed during the author's life in the Northwest—on the frontiers of civilization—and bear the marks of the personal acquaintances which he says he has had with Indians of the Dakota and Ojibway nations. A considerable proportion of them relate to Indian subjects, and, in versifying Dakota legends, the attempt has been made to present faithfully many of the customs and superstitions and some of the traditions of that people. While very little poetic license has been taken with their traditions, none has been taken with their customs and superstitions. These poems may therefore be regarded as contributions to Indian lore. Published in Chicago by Laird & Lee.

Simeon Pease Cheney, author of the American Singing-Book, was a musician and music teacher, who lived thirty summers in a bird-haunted grove, and who took notice of bird songs in Vermont, New Hampshire; St. Lawrence County, New York; and southern Massachusetts. In his sixty-seventh year, with no authorities but his own observations—for he never read but four books about birds, and these not till more than half the work he accomplished was done—he undertook the collection of New England bird-songs. His intention was to write a book for the young people of New England, to be made up of bird-songs and observations on the domestic animals, with special reference to their several forms of utterance, and of notices of the music of inanimate things. He died with his work unfinished in May, 1890. His notes have been collected and edited by Mr. John Vance Cheney, and are published, with much supplementary matter in the appendix, as *Wood Notes Wild*, by Lee & Shepard, Boston. The author warmly controverts the assertion of a modern English writer that there is no music in Nature, and in contradiction of it presents a transcript of the song of water dropping into a bucket, and the melody of a whirling clothes-rack. Following these, he gives his observations and transcriptions of the notes—some of them forming various melodies—of forty-one birds, beginning with the bluebird and robin, and closing with owls and the hen—all of which, he avers, contain the essential elements of true music. In the appendix, the editor presents all that he has been able to find, by citation or reference, that has been said by other authors on the music of birds, and has combined much valuable information on the subject.

The Financial History of Massachusetts, from the Organization of the Massachusetts Bay Company to the American Revolution, is a volume of the Columbia College Series of Studies in History, Economics, and Law, by *Charles A. Douglas*. It is presented as a necessary antecedent to an intelligent investigation of the financial phenomena of the later period of the history of the State, which are regarded as far more complex, as well as fuller of interest, than those embraced within the scope of the present essay. In his treatment the author has given space to the exposition of administrative features, rather than to numerical statements—very properly, we think, in view of the close relation of such features to fundamental principles, and of the fragmentary and unsystematic character of the financial records. We are sorry to observe the author apologizing for involved style in some parts of his work. With a language so capable of giving clear and simple expression to every thought as the English, we can recognize no sufficient excuse in a careful work for the want of it.

Opposite views of the money question are taken in two pamphlets that are before us—Two *Essays in Economics*, by *John Borden* (S. A. Maxwell & Co., Chicago), and a lecture by *Alfred B. Westrup* on *Citizens' Money* (The Mutual Bank Propaganda, Chicago). Mr. Borden's essays are on Wealth and American Money, and are well-reasoned and well-tempered presentations of the sound financial view that the circulation must have a basis of real value. Wealth is defined, its different kinds are distinguished, false definitions of it are exposed, and it is considered with reference to its sum and its owners. In American Money are discussed the standard, tokens, the medium of exchange, the volume of the currency, money as a store of wealth, and paper money. In his lecture on Citizens' Money, Mr. Westrup insists that sufficient volume and facilities must be provided to enable all wealth to be represented by money; that this representative should be loaned at cost; that absolute security must be given to the holder of paper money; and that the present system of control and restriction of the currency by Government is wrong.

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POPULAR MISCELLANY.

The American Tea Plant.—The *Ilex cassine*, or *youpon*, is a shrub or small tree which grows in the Southern States, along the sea-coast, to not more than twenty or thirty miles inland, from Virginia to the Rio Grande. Its leaves and tender branches were once used by the Indians in the same way that the Chinese tea and the Paraguay tea are used. But the drinking of this tea has been nearly if not quite abandoned. A study of its history has been made by Dr. E. M. Hale, who has examined all the references to it he could find, and has started an inquiry into the reason why it has been abandoned, and the expediency of reviving its use. Its leaf, according to the analysis by Prof. Venable, of the University of North Carolina, contains caffeine. It is not so pleasant in odor and taste as the Chinese tea; but it seems to have some salutary properties which the latter does not possess, and may perhaps be more cheaply obtained. Dr. Hale estimates the extent of the land over which it grows as about forty thousand square miles, and suggests that careful experiments in cultivation and manipulation might result in furnishing our markets with a product that would be found in many cases an acceptable and useful substitute for the more expensive imported teas.

Many-toed Horses.—The derivation of the recent horse's foot with one digit from ancestors with polydactyl feet has been carefully traced by Prof. O. C. Marsh in his published papers on that subject. Several instances have come to the author's knowledge of existing horses presenting more than one toe. Julius Cæsar's horse had this peculiarity. Its feet are described by Suetonius as having been almost human, with the hoofs cleft like toes. "It was born in Cæsar's own stables, and, as the soothsayers declared that it showed that its owner would be lord of the world, he reared it with great care, and was the first to mount it. It would allow no other rider." The main functional toe of each foot of the horse is the third digit, corresponding to the middle finger of the human hand. In addition to these, two "splint-bones," one on each side of the main cannon-bone, are present beneath the skin—the remnants of two other toes possessed by ancestors of the horse. One or more of these splint-bones may become enlarged below and support phalanges, forming another digit beside the main one, or, more commonly, developing into a small external toe, with hoof. The occurrence of such extra digits in the recent horse is much more frequent than is generally supposed. Prof. Marsh has examined several living animals presenting this peculiarity, and has received photographs, drawings, and detailed descriptions of others. The extra digit may appear on one foot, when it is smaller than the main digit, and is usually on the inner side on the fore foot. It may often be entirely under the skin, with the only external evidence of it a prominence, in which its form may be made out. A corresponding extra toe may be present on the other fore foot; a second extra digit may exist with the others, but outside the main digit; with the extra inner toes of the fore feet, another of equal or smaller size may be present on one or both of the hind feet, almost always on the inside; in rare cases, both fore and hind feet may each have two extra digits fairly developed, and all of nearly equal size; or sometimes, besides the extra toes already described, which appear to be the second and fourth, the first digit, or pollex, may be represented by its metacarpal, supported by a distinct trapezium, all beneath the skin. A large majority of the polydactyl horses known to Prof. Marsh in this country have been raised in the Southwest, or from ancestry bred there, so that their connection with the mustangs or semi-wild stock of that region becomes more than probable. The fact that the tendency to reversion is much stronger where animals run wild must be taken into consideration in discussing the question of the origin of these animals.

Temperature of Lake Waters.—The investigations of Mr. A. T. Drummond on the temperatures of some Northern lakes and rivers have shown him that the Georgian Bay is, in its main expanse, a large body of cold water whose temperature, at its greater depths, is not much influenced by the heat of summer, while the central and southern basins of Lake Huron, although also receiving surplus waters from Lake Superior, stand in the line of inflow of the warmer waters from Lake Michigan and of their ultimate exit by way of the river St. Clair to the lower lakes, and are consequently somewhat warmer basins. Among the details of observations recorded in his papers, we find that tests at the rapids of the Richelieu River at Chambly seem to show that the motion of the water during the mile of continuous rapid raises the temperature of the water perceptibly. Rapid currents have, however, the effect of equalizing the temperature of the water. Under conditions appearing to be the same, and at points relatively near to each other, the water on the surface of the lakes and rivers is not uniform in temperature, but seems to flow in areas of different temperatures. It is impossible to lay down any general rule regarding the changes of temperature varying with the increase in depth. Apart from variations resulting at the different seasons, surface readings are affected by sunlight and cloud, gusts of wind, channel currents, the inflow of affluent streams, and the physical features of the surrounding land. Readings beneath the surface are affected by the depth of the water, by ordinary currents resulting from changes of level, by evaporation at the surface creating an upward flow of the water underneath, by the contour of the bottom, and by high winds which drive the surface waters before them, creating return currents underneath to take their place. The general rise of the temperature of Lake Ontario waters as the summer advances is at first slow, compared with the general rise of the temperature of the air, but, as midsummer is reached, the rise is more rapid both at the surface and at the bottom. The absorption and retention power of the sun's heat is most noticeable in the small streams and quiet pools. In the case of rivers, the air in direct contact with the warm surface of the water has its temperature in early August raised to from 1° to 5° above that of the air directly above, but in more exposed positions; and this increase in temperature, which is greatest at the point of contact, is, at one foot above the surface of the water, already to a considerable extent lost.

The Value of Human Testimony.—The argument of a book by Mr. Thomas Fitzarthur on the Value of Human Testimony is, according to the summary of The Spectator, that the value depends in a great measure on the importance attached by the witness to the facts to which he testifies. If the fact is insignificant, if his interest in it is languid, and it has no real bearing on his life, it is not to be supposed that he will take the trouble to attend to the matter with the care and the anxiety to be sure of what he sees or hears which is necessary to make his testimony of real weight for other people. But if it is a fact on which a great change in his own career depends, if it alters his whole life, his whole character, if it involves him in much labor and suffering, if it kindles in him an altogether new ideal of purpose, then we may be sure that his testimony is both honest and careful, and that, if it is supported by a great deal of other testimony of the same nature, it is in the highest degree trustworthy. Further, the author insists that its transmission through a long line of tradition does not invalidate its authority. We should not attach much value to details so transmitted. If we were dependent on testimony transmitted from generation to generation as to the numbers and character of the forces engaged in the battle of Hastings, we should not attach much weight to it. But such a long line of transmission would not diminish the value of the testimony as to the reality of that battle, and its result in the defeat of the Saxon and the victory of the Norman army. We should be well aware that that testimony must have been transmitted through a great many unwilling as well as a great many willing and triumphant witnesses. We should be well aware that all those witnesses must have had before their eyes the amplest evidence of the actual event, and of the revolution it brought about in the history of England. And we should never think of supposing anything so absurd as that at some specific date there was a deliberate conspiracy formed by hundreds of thousands of living Englishmen to alter the whole drift of the testimony they had received from their fathers, and invent a battle which never took place, or reverse its issue, and that that conspiracy should have succeeded in persuading the unborn generations to believe a gigantic lie. There could be neither machinery nor motive for such a successful conspiracy, and consequently the common sense of mankind at once rejects a hypothesis so audacious and absurd, with contempt.

Miss North's Animal Friends.—Miss Marianne North relates, in her Recollections, that while sketching an old Hindu temple at Blaune Watu, Java, she felt hungry and began eating a biscuit as she went on with her work. Shortly she was disturbed by a pull at her dress, and found a large monkey sitting beside her and looking reproachfully at her, "with the expression of 'How can you be so greedy? why don't you give me a bit?' Of course he did get it, and then departed and hid himself in the leaves overhead." At a place in California, where she stayed after all the other visitors had deserted it, "a stag," she says, "with great branching horns was my only companion; he had a bell round his neck, and used generally to live in front of the house, but liked human company; and when I appeared with my painting things he would get up and conduct me gravely to my point, and see me well settled at my work, then scamper off, coming back every now and then to sniff at my colors."

The Succession of American Floras.—No strongly defined line can be drawn, says Prof. Warren Upham, in a paper on the flora of the basin of the Red River of the North, "between different portions of the flora and fauna of the country from the Atlantic to the Rocky Mountains and from the Gulf of Mexico to the Arctic Sea. But great contrasts exist between the Eastern region, with its plentiful rainfall, and the dry Western plains, as also between the almost tropical Southern margin of the United States and the tundras beneath the Arctic Circle. In traveling from the once wholly forest-covered country of the Eastern States, across the prairies, to the far Western plains bearing cacti and sage-brush, there is observed a gradual change in the flora, until a very large proportion of the Eastern species is left behind, and their places are taken by others capable of enduring more arid conditions. Likewise, in going from St. Augustine or New Orleans to Chicago, St. Paul, Winnipeg, and Hudson Bay and Strait, the palmettoes, the evergreen live-oak, bald cypress, Southern pines, and the festooned *Tillandsia*, or Spanish moss, are left in passing from the Southern to the Northern States; and instead we find in the region of the Laurentian lakes the bur or mossy-cup oak, the canoe and yellow birches, the tamarack, or American larch, the black spruce, balsam fir, and the white, red, and Banksian pines; while farther north the white spruce, beginning as a small tree in northern New England and on Lake Superior, attains a majestic growth on the lower Mackenzie in a more northern latitude than a large part of the moss-covered barren grounds which reach thence eastward to the northern part of Hudson Bay and Labrador. Thus, although no grand topographic barrier, like a high mountain range, impassable to species of the lowlands, divides this great region, yet the transition from a humid to an arid climate in passing westward, and the exchange of tropical warmth for polar cold in the journey from South to North, are accompanied by gradual changes of the flora, by which in the aggregate its aspect is almost completely transformed."

Timber-testing.—The Forestry Division of the Department of Agriculture is engaged in making tests of timber, for the purposes of obtaining a better knowledge of the qualities of our commonest commercial timbers; of devising means of relating qualities to physical structure and appearance; and to establish, if possible, the influence which divers conditions of growth exercise upon the quality—all conditions affecting the usefulness of the specimens in service. The records, which are preserved in duplicate, include the definition of the locality where the piece was cut, with its geological and climatological features; an exact description of the site and exposure, the soil, and the surrounding growth and undergrowth; the origin of the tree, its age and dimensions; the positions in the tree of the various test-pieces submitted; and other points. It is expected to submit to the regular series of tests between one and two thousand test-pieces of each species. It is hoped that when the work is done means will be afforded the engineer and architect to specify for timber of given quality, and also, by a rapid macroscopic and microscopic examination, to pass on each stick as to its coming up to the specification; and, further, of acquainting ourselves with the conditions of growth that produce given quality.

The Preservation of Historical and Interesting Scenery.—At the instance of the Appalachian Mountain Club, a law has been enacted in Massachusetts incorporating a Board of Trustees of Public Reservations, with authority to acquire, hold, arrange, maintain, and open to the public, under suitable regulations, beautiful and historical places and tracts of land within the Commonwealth. The property thus acquired, which can not, with its appurtenances, exceed two million dollars in aggregate value, is exempt from taxation, unless it is held longer than two years without being opened to the public. While the corporation enjoys these privileges, it is forbidden to own any capital stock or to make any division of property or income among its members, or any dividends. Mr. George F. Hoar has been chosen President of the Board. The trustees received last year several recommendations or offers of property as coming within the category of the purposes for which they are acting, and have considered the expediency of purchasing them; and Mr. J. B. Harrison, their agent, has made an inspection of the sea-coast towns of the State, with a view to the provision of public access to the beach and the establishment of seashore parks. The establishment of the board will enable the admirers of the scenery or history of any spot in the State to make that spot a reservation and to provide for its perpetual care, and will enable the proprietors of pleasure resorts and the people of communities which make money from the attractiveness of fine scenery to insure the perpetuation of such attractions and of their profits. Similar provisions should be made in all the States.

Characteristics of Star Spectra.—The general conclusion derived from the study of the spectra of the stars, says Prof. E. Pickering, in his account of the Henry Draper Memorial, is the marked similarity in constitution of different stars. A large part of them—the stars of the "first type"—have a spectrum which at first sight seems to be continuous, except that it is traversed by broad dark bands, due to hydrogen. Closer inspection shows that the K-line is also present as a fine dark line. If the dispersion is large and the definition good, many more dark lines are visible. These lines may be divided into two classes: First, those which predominate in many stars in the milky way, especially in the constellation of Orion; and, second, those present in the solar spectrum. Nearly all the brighter stars may be arranged in a sequence, beginning with those in Orion, in which the auxiliary lines are nearly as intense as those due to hydrogen. Other stars may be found in which these lines successively become fainter and fainter, till they have nearly disappeared. The more marked solar lines then appear, become stronger and stronger, and the hydrogen lines fainter, till they gradually merge into a spectrum apparently identical with that of the sun. Continuing the sequence, the spectra pass gradually into those of the third type. Certain bands become more marked, and the spectra of the third type may be divided into four classes, in the fourth of which the hydrogen lines are bright instead of dark. This spectrum appears to be characteristic of the variable stars of long period when near their maximum. It has led to the detection of several new variable stars, and has been confirmed in many of the known variables. Slight peculiarities are noticed in the spectra of many stars, but these deviations are not sufficient to affect the general law. Stars of the fourth type, whose spectra appear to be identical with the spectrum of carbon, are not included in this classification. Other stars, whose spectra consist mainly of bright lines, like those of the planetary nebulæ, may be included with them in a fifth class.

The Reason of the Slave Trade.—A Moslem view of the slave trade is presented in the Saturday Review—not to excuse the traffic, but to show why it is carried on. The slaves are mostly children, "black, uncomely, and unpromising." They are not sought for the harem, in the conventional sense of that word. "The truth is, that certain conditions of domestic life among civilized Moslems exact a supply of slaves without regard to beauty or even to physical strength. The interruption of that supply has caused as much dismay and confusion as a law to forbid the employment of unmarried girls for household service might effect in England. It would be found at once that there were not matrons or widows enough to do the work, that few of them would undertake it, and fewer still were competent. Such a law would be evaded at every peril. No class of women in a Moslem community has the tradition of domestic service, as it may be called. Very commonly a free girl was taken into the household of some matron as a child, and there brought up; but she never dreamed of changing. One of the conditions was, and is, that her patroness shall provide a husband for her. Often enough, also, the child of such a *protégée* succeeds to her place when old enough, and thus very pleasing relations are established between families of different status. . . . The practice of adopting girl-children to train as servants becomes more and more common as slaves become scarcer. . . . A class of domestic servants is being formed which, in due time, will replace the slaves. But transformations of the sort are very, very slow in the East. Meanwhile the process is very disagreeable, even shocking, to Moslem housewives, and it is not at all surprising that they should pay heavily and run some risk to obtain a negro who is all their own."

Lake Beaches.—In his discussion of the beaches and their correlative moraines of Lake Erie, in the American Journal of Science, Mr. Frank Leverett shows that the belief of geologists now is that the phenomena do not demand a submergence of the land during the closing stages of the Glacial epoch; that, instead of a depression, there was a greater altitude than in the earlier part of the period; and that the result of investigation has been to reduce the noteworthy lakes connected with the closing stages of glaciation in Ohio to the one bounded by the beach lines that were recognized by the Ohio Geological Survey. The examination of the phenomena in detail leads to the conclusion that Lake Erie, in its earlier stages, was but a small body of water, its size being conditioned by the position of the retreating ice-sheet and by the height of the western rim of the basin it occupied.

NOTES.

The arrangements for the meeting of the American Association, to be held in Rochester, N. Y., in August, are nearly completed. The meeting will be opened on Tuesday evening, the 17th, with an address by Secretary F. W. Putnam. President Joseph Le Conte will deliver an address on Wednesday evening, the 18th; a reception will be given the Association by the ladies of the city at the Powers Art Gallery on Thursday, the 19th; and a public lecture will be given on Friday evening. The business meetings will be held in the university. The Saturday excursions will include visits to Niagara Falls, Portage, Mount Morris, Canandaigua Lake, and Watkins Glen, and the long excursion will be to the Adirondack region.

The second annual session of the School of Applied Ethics will be held at Plymouth, Mass., July 6th to August 17th. The programme of instruction includes six courses of five lectures each in the History of Religions; seven courses in Economics; and a series of fifteen lectures by Prof. William Wallace, of Oxford, on Variations of the Moral Standard, illustrated by the History of Ethical Theories; with four other courses in Ethics. Applications may be made to the secretary, S. Burns Weston, 118 South 12th Street, Philadelphia.

In Uruguay, according to Admiral Kennedy, of H. M. S. Ruby, barbed wire has played a part in suppressing revolutions, as it is not easy to march troops over a country intersected by it.

A *Postschule* is to be established at Leipsic for the special training of post-office assistants, and eventually also of postmasters. The course of instruction will embrace, besides the usual branches, the subjects belonging to the postal service.

According to Dr. R. W. Shufeldt's observations of the Navajo belt-weavers, curves are never found in the figure-patterns on the belts or blankets, but horizontal stripes, diagonals, and the lozenge are interwoven with a variety that appears to be almost endless in the matter of design. The leading colors used are red, brilliant orange-yellow, a blue, and by combination a green, and black, white and gray.

The results of the observations of Mr. H. C. Russell, of Sydney, on the Grouping of Stars in the Southern Part of the Milky Way were described by him at the Australasian Association as tending to diminish the value of the rifts in the discussion of stellar distribution.

The detailed meteorological observations, made under the direction of H. B. de Saussure simultaneously on the *Col du Geant*, at Geneva, and at Chamounix, in July, 1788, have been published in the memoirs of the Physical Society of Geneva. Only the means of a part of the observations were published by De Saussure in his Voyages dans les Alpes.

The nest and egg of a bird-of-paradise have been found by two Australian gentlemen on an island off the coast of Queensland, and have been described by Mr. A. J. Campbell in the Victoria Field Naturalists' Club. The hen was watched till she flew into the crown of a pandanus tree, where her head could be seen as she sat on her nest.

The nest was about ten feet from the ground, and was somewhat loosely constructed of broad, dead leaves and green branchlets of climbing plants and fibrous material. Inside were two large concave dead leaves underneath pieces of dry tendrils, which formed a springy lining for the egg or young to rest upon. The nest contained a single egg; was nineteen centimetres broad and nine deep; and the egg cavity was nine centimetres by four.

A proposition to establish a marine biological station in Jamaica as a memorial of Columbus is approved by Prof. Huxley and Prof. Ray Lankester, who regard the situation as a most excellent one for the study of intertropical life.

A small axe of nephrite found at Ohlau, in Silesia, has been identified as to the specific gravity, microscopic structure, and chemical composition of the stone, as the same with a mineral occurring near Jordansmühl, in Silesia. This is the only prehistoric object found in Europe of which the source has been satisfactorily determined.

Among the items of progress in chemistry in Australia, Mr. W. M. Hamlet mentions the discovery of the alkaloids brucine and strychnine in the fruits of *Strychnos pilosperma*, by Prof. Rennie and Mr. Goyder; and the work done by Mr. J. H. Maiden in the examination of Australian kinos, gums, and barks. Chief among this chemist's researches was his work on wattle bark, which he found contains from fifteen to forty-six per cent of tannic acid. As the wattle tree is easy of cultivation, it thus promises to be valuable. Mr. Kirkland has discovered gallium and indium in some specimens of blende. Some work has been done toward determining the actual state of combination in which elements occur in different ores.

The first part of an account of the origin and development of the Royal Gardens at Kew has been published by Mr. Thiselton Dyer, in the Kew Bulletin. The present installment of the story relates the earlier period of the history, when the gardens were a purely private possession of the crown, and closes with the time when, in 1841, they became a national institution, with Sir William Hooker as director. For this early period there are hardly any authentic records, and the author has had "to fall back on local traditions, on local histories, the statements of which are often confusing and inaccurate, and on such scattered notices as could be gathered from contemporary literature." The history of the last half-century of the gardens will be given in another number of the Bulletin.

In a lawsuit recently decided in London, a householder had two poplar trees near a railway, which the railway company wished removed. He was willing to shorten the branches, but not to cut the trees down. The company sent in its men, who felled the trees, and then offered to settle with the owner, first by giving him two hundred and fifty, and later by offering him five hundred dollars. He carried the case to the court, which gave him fifteen hundred dollars for the trees and additional damages of a thousand dollars for the injury caused by their removal.

Violets of highly intensified colors have appeared on the streets of Paris, where curiously colored lilacs and narcissuses are likewise offered for sale. According to M. Gaston Tissandier, in *La Nature*, the flowers sold in Paris are artificially colored by placing the stems in water containing an aniline dye of the tint desired.

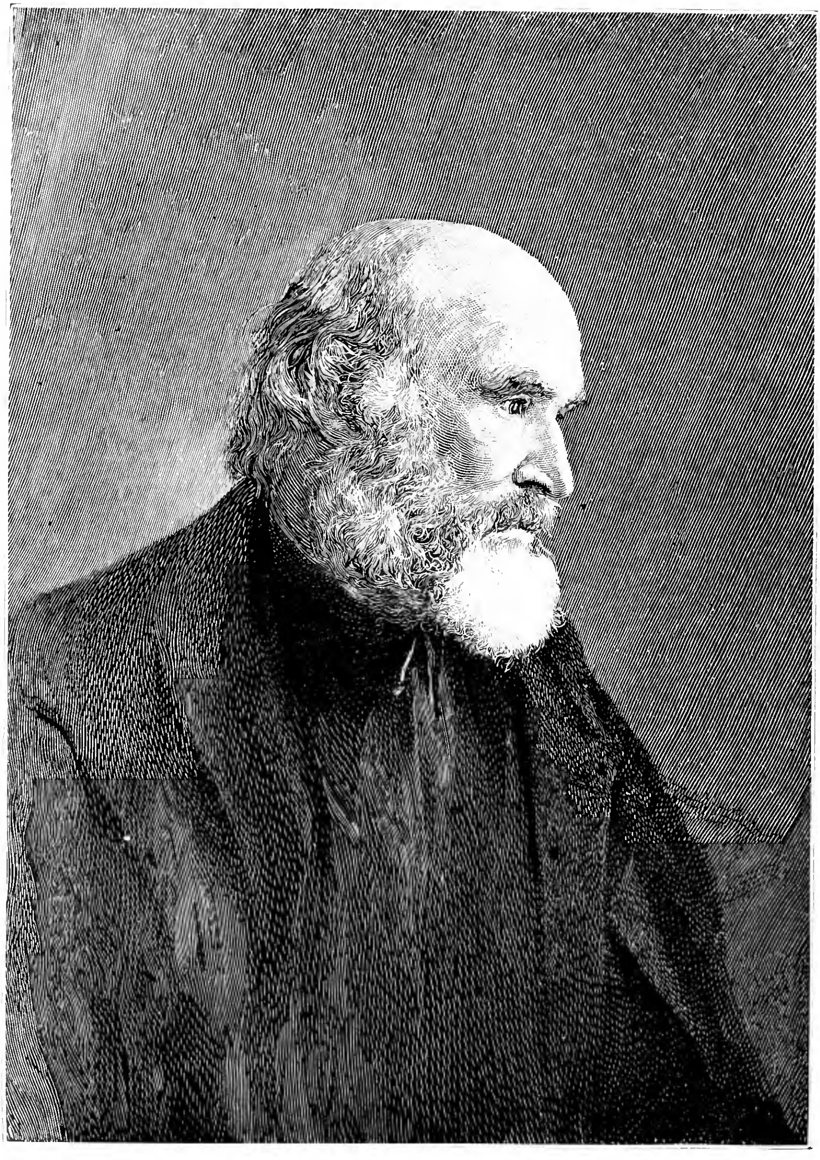
Mr. Smee, of the Gresham Insurance Company, is credited with having declared that the company has paid out during the past two years, on account of deaths caused directly by influenza, two and a half times as much as it paid in forty-three years for deaths by cholera.

An exhibition of weeds at the World's Columbian Exhibition is projected by Prof. Byron D. Halsted, who suggests that each person assisting secure at least three specimens each of the worst weeds in his State or section. Regard should be had, in collecting them to the seeds, which are especially desired; seedlings in various states of development; the root system; the flower and flower cluster; and the seed-vessel. To avoid unnecessary duplication, persons designing to collect for this enterprise are invited to communicate with Prof. Halsted at the State Experiment Station, New Brunswick, N. J., when their work will be arranged for them.

A curious custom is described by Dr. J. C. Evans as having prevailed at Oakham, Rutlandshire, England, by which a horseshoe, or payment in lieu thereof, was exacted from every peer passing through the town. The author exhibited to the Society of Antiquaries an iron horseshoe of super-equine dimensions, which had been deposited in the hall at Oakham in 1693, by Richard Cumberland, Bishop of Peterborough.

OBITUARY NOTE.

Hermann Franz Moritz Kopp, a famous German chemist, died at Heidelberg, February 20th, in the seventy-fifth year of his age. He joined Liebig in 1813 at Giessen, where he labored for nearly twenty-five years; became a privat-docent in the university in 1841, an extraordinary professor in 1843, and an ordinary professor in 1853; and was called to Heidelberg in 1864, where he remained till his death. His specialty was physical chemistry.



JOHN COUCH ADAMS.

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NATURAL SELECTION AND CRIME.

By Prof. EDWARD S. MORSE.

"Find out what the law of God is with regard to a man; make that your human law, or I say it will be ill with you, and not well! If you love your thief or murderer, if Nature and eternal Fact love him, then do as you are now doing. But if Nature and Fact do *not* love him? If they have set inexorable penalties upon him, and planted natural wrath against him in every god-created human heart—then I advise you, cease, and change your hand."—Carlyle.

THE appearance of General Booth's work, entitled In Darkest England, was followed by a deluge of opinions, articles, and reviews on crime, vagabondage, tenement-houses, slums, etc. The serious spirit of these utterances showed an earnest awakening of the public mind in regard to the ominous character of the submerged classes.* To meet this baleful increase of vagabondage and crime we have had, first, punitive measures, even to mutilation, with no effect whatever, except perhaps as a deterrent to a few of the many thousands implicated; next, indiscriminate charity—public and private—still active in all but a few enlightened cities, with the effect of causing an alarming increase in the number of paupers and tramps; later, organized relief, which, being selective in a measure, results in some good being accomplished; and, finally, the Salvation Army, with rank and file mostly filled from the very classes demanding relief and reform. It would be strange indeed if such an organized force should not leave its impress on the chaotic material of the slums. That a great deal of temporary good, at least, is being accomplished by this organization there can be no doubt.

* Concerning General Booth's scheme, we commend a very just and temperate article in Blackwood's Magazine for January, 1891, entitled The Problem of the Slums.

The subjects of crime and insanity have often been discussed under a common title. In the law courts the plea of insanity is often raised in defense of the criminal. A review of the treatment of maniacs in past times, and criminals at the present time, shows many curious analogies. For these several reasons let us briefly examine the attitude of society toward these unfortunates who are animated in their behavior by the possibly related conditions—insanity and crime.

Insanity was formerly looked upon as evidence of demoniacal possession. The idea that a disordered intellect could be the result of physical disease—of lesions of the brain—was only established after centuries of observation. In the mean while, every torment that misguided man could inflict was frantically suffered by untold thousands of chained and caged victims. Now, thanks to science, a thin section of diseased brain may, by means of the lantern, be projected upon a screen, so that audiences of thousands can realize for themselves the pathological nature of certain forms of insanity.

Dr. Andrew D. White, in his chapter on Demoniacal Possession and Insanity,* says: "If ordinary diseases were likely to be attributed to diabolical agency, how much more diseases of the brain, and especially the more obscure of these! These, indeed, seemed to the vast majority of mankind possible only on the theory of satanic intervention."

It would be difficult to find a more ghastly page of history than is embodied in the two chapters on insanity by Dr. White in his New Chapters in the Warfare of Science. One becomes transfixed with horror at the merciless and ignorant brutality exercised in the treatment of the insane. Patients who required the tenderest care and long-continued sleep were forcibly kept awake for days to drive out the devil that was believed to possess them. Science, long thwarted by the Church, finally wrought a marvelous change in the treatment of these unfortunate creatures, by substituting gentleness, airy rooms, and sunny fields for dungeons, exorcisms, prayers, and blood-curdling cruelties. To one at all familiar with the external aspects of insanity, in its various forms, it seems incredible that its physical nature was not sooner realized.

The writer has had some slight knowledge of insane asylums, not only in America but in Japan, China, and Java, and in all these places, with their different nationalities and consequent facial peculiarities, one could easily recognize melancholia, dementia, and certain other forms of mental disease. The asylum at Buitenzorg, in Java, was of special interest, for here one

* Popular Science Monthly, vol. xxxiv, p. 434.

might see in the different wards Sundanese, Javanese, Chinese, Hindoos, various Europeans, and peoples from other countries, with widely varying features, yet the "cachet," so to speak, of the mental disease could in many cases be recognized at a glance. Had the laws of heredity, even, been earlier understood it would have been seen that mental derangements, like physical diseases and tendencies, were transmitted.

If insanity was formerly considered the evidence of satanic possession, how much more reason was there to believe that delinquencies of a criminal nature were the result of satanic instigation. While demoniacal possession, as an explanation of insanity, is discredited on all hands,* criminal acts are still looked upon as the instigation of the devil. It may be safely asserted that to-day the vast majority of mankind fully believe that an external influence for evil is at war in the individual with an external influence for good.

Atrocious crimes are especially referred to as the result of diabolical suggestion; and the same procedures, though in a milder form, which obtained in former times for the treatment of the insane are in full force to-day in the treatment of the criminal. In the one case, however, torture was used to drive the devil out, in the other the victim is punished for yielding to the devil's persuasion. The criminal is imprisoned, chained, immured in a dark cell, forced to severest labor, and in many prisons abroad subject to physical torture. Under some governments he is transported to torrid climates and compelled to work under a broiling sun, or, hidden from the sun altogether, to delve in mines. This much for the punishment. Similar methods are resorted to in attempting reform, as were formerly used in exorcising the devil from the maniac. The minister and priest, having at all times free access, exhort and pray for the criminal, that he may have strength to resist the evil spirit, and if some sudden revulsion of feelings animates him to struggle against his criminal impulses, as many an insane man succeeds in controlling his maniacal impulses, then it is believed that a new spirit has shed its beneficent influence upon him, or, in other words, the evil spirit has been exorcised. Those who strenuously protest against such an interpretation of sin and crime are branded with obnoxious names. Dr. White says that perhaps nothing did so much to fasten the term "atheist" upon the medical profession as the suspicion that it did not fully acknowledge diabolic interference in mental disease.

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* This holds good for the present time, but a firm belief in the existence of demoniacal possession in past times is still held by the Church, as lately witnessed in the discussions between Huxley and Gladstone, Dr. Wace, and others, regarding the Gadarene pigs.

A further analogy may be seen between the treatment of the lunatic in past times and the treatment of the criminal in recent years. It will be admitted without question that the former treatment of the insane could only result in driving the victim to utter madness. In an interesting work, entitled Old Bailey Experience (1833), the writer, who shows himself far in advance of his time, in reflecting on the treatment of criminals in England, says, "So convinced am I that the manner in which the laws are administered, under the discretion of the judges at the Old Bailey, has been one of the chief causes of the increase of crime, that it is a perpetual source of concern to me, that the subject has not been taken up by some one more able than myself to awaken the attention of the public." And he proves his position by an overwhelming mass of evidence.

Of late years there has sprung into existence a school of criminal anthropology, with societies, journals, and a rapidly increasing literature. A most admirable summary of the work thus far accomplished has recently been given by Dr. Robert Fletcher, in his address as retiring President of the Anthropological Society of Washington. In his opening paragraphs Dr. Fletcher graphically portrays the scourge of the criminal and his rapid increase. "In the cities, towns, and villages of the civilized world, every year, thousands of unoffending men and women are slaughtered; millions of money, the product of honest toil and careful saving, are carried away by the conqueror, and incendiary fires light his pathway of destruction. Who is this devastator, this modern 'scourge of God,' whose deeds are not recorded in history?—The criminal! Statistics unusually trustworthy show that if the carnage yearly produced by him could be brought together at one time and place it would excel the horrors of many a well-contested field of battle. In nine great countries of the world, including our own favored land, in one year, 10,380 cases of homicide were recorded; and in the six years, extending from 1884 to 1889, in the United States alone, 14,770 murders came under cognizance of the law.

"And what has society done to protect itself against this aggressor? True, there are criminal codes, courts of law, and that surprising survival of the unfittest, trial by jury. Vast edifices have been built as prisons and reformatories, and philanthropic persons have formed societies for the instruction of the criminal and to care for him when his prison gates are opened. But, in spite of it all, the criminal becomes more numerous. He breeds criminals; the taint is in the blood, and there is no royal touch which can expel it."

Certain results of the modern school of anthropology, as presented by Dr. Fletcher, may be briefly summed up by stating broadly that in studying the criminal classes from the standpoint of anatomy, physiology, external appearance, even to the minuter shades of difference in the form of the skull and facial proportions, the criminal is a marked man. His abnormities are characteristic, and are to be diagnosticated in only one way. That these propositions are being rapidly established there can be no doubt. As an emphatic evidence of their truth, the criminal is able to transmit his criminal propensities even beyond the number of generations allotted to inheritance by Scripture.

William Douglas Morrison, in his Crime and its Causes, while denying these propositions, admits that degeneracy and disease are transmitted, and in these conditions seeks for the origin of crime.

A very significant relation is shown between crime and insanity in figures given by Malcolm Morris, as quoted by Dr. Emily White, in her address on Hygiene as a Basis of Morals.* She says: "The intimate relationship between nervous diseases and crime is conspicuous. In England, the ratio of insane to sane criminals is thirty-four times as great as of the insane to the whole population, and criminal lunatics are in excess in the high proportion of seventeen to one." The persistence of criminal and vagabond taints is even more pronounced than that of lunacy; the latter condition often yields to benign treatment, and there is reason to believe that in time it may be eradicated, though confinement and consequent prevention of offspring will be the main cause of its disappearance. Whether criminal propensities can be obliterated is a grave question. Certainly the irrational and unscientific methods in the treatment of criminals to-day are as much responsible for the increase of crime as were the superstitious and unscientific ways of dealing with contagious diseases in earlier times responsible for their wide dissemination.

The repeated association of certain abnormities of the body with the criminal character suggesting simian features has led to the idea that congenital criminals are instances of reversion. Eminent students in this branch of study call attention to the resemblances of many minor details of structure to features in the higher apes. Dr. Fletcher admits that, while this view may be correct, it is purely hypothetical. The presence of certain abnormal muscles in man have been justly looked upon as evidence of reversion, and certainly the atavistic view clears up many points of structural difference seen in the criminal class which would otherwise be obscure. It is possible, however, that if the antecedents of all criminals were known, retention of ancestral traits and not reversion would be the more probable explanation

* Popular Science Monthly, May, 1887.

of the continuance of the congenital criminal. He has always existed; his presence is apprehended just in proportion to the sensitiveness of the public conscience. Morrison, in his instructive book, says, in regard to the confirmed vagabond and criminal, that "most of them are not adapted to the conditions of existence which prevail in a free society. Some of them might have passed through life fairly well in a more primitive stage of social development, as, for example, in the days of slavery or serfdom; but they are manifestly out of place in an age of unrestricted freedom, when a man may work or remain idle just as he chooses. . . . All men are not fitted for freedom, and, so long as society acts on the supposition that they are, it will never get rid of the incorrigible criminal."

The persistence of those acts which, as society has evolved, have been deemed criminal, are acts natural to all animals. In the decalogue half the commandments, significantly grouped together, refer to acts and impulses inherent in the animal kingdom, from the lowest to the highest. Murder and adultery, of course; covetousness precedes the act of stealing; theft, in its various forms, from the simplest act to stock-watering; and lying, from the deceptive behavior of a bird to the lies embodied in the advertisements of the modern newspaper—are all part and parcel of man's inheritance.

Dr. Bruch Thomson, Surgeon of the General Prison, Scotland, says, "Habitual criminals are without moral sense—are true moral imbeciles." Carl Vogt advanced the idea that certain cases of congenital idiocy were evidences of reversion. Let one spend a few hours only in the worst wards of an asylum for the feeble-minded, and attentively study the movements and desires, the wanton mischief, the shocking impulses which animate these unfortunate creatures, and he is forced to admit the possibility of such a condition.

Whatever view prevails does not concern us at present. The important truth to realize is that overwhelming and incontestable evidence shows that the criminal, as a type, not only exists, but that his criminal taints are transmitted, and that this transmission may run through many generations. It is proved by voluminous evidence, easily accessible, that children are born criminals. They are, as Dr. Fletcher says, not only reared, nurtured, and instructed in it, but the habit becomes a new force—a second nature—superinduced upon their original natural depravity. In speaking of this class he says, "These communities of crime, we know, have no respect for the laws of marriage, are regardless of the rules of consanguinity, and, connecting themselves only with those of their own nature and habits, they must beget a depraved and criminal class, hereditarily disposed to crime."

It should be understood that in speaking of criminals the modern classification of criminals is recognized, and only the instinctive or congenital criminals are here considered. In this presentation, however, we must include the vast army of tramps who move with the snow-line back and forth across the country; a horde continually increasing because, as with the criminal, the vagabond strain is continually being bred. This startling truth of inheritance must be emphasized again and again, till the public mind—slow to understand—shall finally realize the fact and take the same stern measures for suppression that it would in the case of polluted water-supply and contagious disease. When these matters were fully understood health boards came into existence, and with such arbitrary powers are they now endowed that a family can be imprisoned in its own house; the house may be destroyed; the dead, if necessary, denied the ordinary funeral observances. The public fully acquiesce in these heroic measures, for the death-rate figures, year after year, become too significant to be neglected.

Vagabonds, like criminals, spring largely from a degenerating stock. The persistence of the vagabond strain, the hopelessness of reform among those blasted with the taint, is strikingly portrayed by the lamented Rev. Oscar C. McCulloch, in an address read before the National Conference of Charities and Corrections (1888), entitled The Tribe of Ishmael, a Study in Social Degradation. Traces of this tribe have been found as far back as 1790, but from 1840 the record is quite made out for some twigs of this baleful stock. Mr. McCulloch says: "The individuals already traced are over five thousand, interwoven by descent and marriage. They underrun society like devil-grass. Pick up one, and the whole five thousand would be drawn up. Over seven thousand pages of history are now on file in the Charity Organization Society" (Indianapolis), and he asks: "Do any of these get out of the festering mass? Of this whole number, I know of but one who has escaped, and is to-day an honorable man. I have tried again and again to lift them, but they sink back. They are a decaying stock; they can not longer live self-dependent. The children reappear with the old basket. The girl begins the life of prostitution, and is soon seen with her own illegitimate child."

The tramp horde is a nidus from which apparently a vast number of criminals spring. The appalling character of the fruits of this nidus may be faintly realized by reference to Dr. Seaman's paper on the Social Waste of a Great City (Science, vol. viii, p. 283). Referring to New York, he says: "It seizes upon and subsidizes the fairest string of islands that grace a metropolis the world over. Where there might have been, under a shrewder, better providence, parks, groves, museums, art-galleries, zoölogical gardens, wholesome games, exhilarants for honest industry and useful thrift, stretching at little intervals from Governor's to Hart's Island, full eighteen miles, the Nemesis of penalty and retribution has planted her growing colonies of social waste, of broken, degraded, repulsive, dangerous human detritus: and this baleful colonization has pushed its way along those beautiful eastern waters, keeping step with the advancing city, until its entire line of eastern frontage, far up into Westchester County, is sentineled by these menacing excrescences of a moribund civilization." Dr. Seaman truly says: "This waste shows a deadly apathy, a dying out of purpose, a fatal estrangement from home, family, and society, for which there has, as yet, been found neither remedy nor cure. This tramp class grows and grows dangerous and desperate too, and is chargeable with an increasing number of outrages, assaults, and crimes against both property and person. The island, the almshouses, and workhouses do not reach or touch their cases, for they gather physical endurance and resources from fresh campaignings across country, until rounded up again by winter weather in the great cities."

Indeed, the daily accounts of innocent women murdered, railroad trains invaded, pitched battles between hordes of these vagabonds and law-abiding citizens, attest to the insidious and rapid spread of this class, and not until some town is burned, and plunder and rape follow the burning, will the people realize what they have for so many years deliberately encouraged by free lunches at their kitchen doors. Indiscriminate charity has been encouraged by religious teaching. Powerful as the Church has been and still is in support of this practice, it is astonishing how rapidly the evils of this pernicious custom are being recognized by charity boards. Mr. McCulloch says the "so-called charitable people who give to begging children and women with baskets, have a vast sin to answer for. It is from them that this pauper element gets its consent to exist. Charity—falsely so-called—covers a multitude of sins, and sends the pauper out with the benediction, 'Be fruitful and multiply.' Such charity has made this element, has brought children to the birth, and insured them a life of misery, cold, hunger, and sickness." And he asserts that so-called charity joins public relief in raising prostitutes and educating criminals. Though these are strong words, they but repeat the testimony of others who have made the subject an attentive study. In an article on London Charities, by Elizabeth Bisland (Cosmopolitan, July, 1891), is quoted the words of an eminent London citizen, who says that London is the scandal of the age by reason of its pauperized and demoralized condition, and yet \$25,000,000 is given each year in alms to the unfortunate. "It is a gigantic laboratory of corruption and crime, and while it aspires to Christianize the heathen, it exercises a far more direct and effectual influence in heathenizing Christians, and in dragging the rest of England down to its own low level." And he goes on to declare that "the enormous facts of London charity are to a lamentable extent responsible for this state of things."

Whether the law-abiding man is abnormal, according to Albrecht, and the criminal is normal—slaying and robbing without compassion, as do the animals below him—does not now concern us, for it has come to pass in the progress of the races that the moral man has formulated laws for the good of society, and insists upon obedience to their establishment. Intelligence and not brute force has become the main factor in man's selection. This has been foreshadowed in past geological times where it has been shown that in the progressive development of the various groups of mammals the brain increased in size out of all proportion to the size of the body. An ignorant man in civilized countries, and even in savage and barbarous countries, occupies the lowest position.

Among the dominant races ignorance, poverty, and crime are often associated. The association of poverty and crime has no immediate relation, as shown by Morrison, though poverty presupposes a low intellect, and this implies an inability to acquire an education, which in a hundred ways in civilized life leads to degeneracy and crime. It can probably be shown that nations that are in the worst plight politically and financially are those where general education is or has been at the lowest ebb, where superstition takes the place of knowledge. In Italy, for example, where an attempt to disinfect cholera districts results in the murder of the officers engaged in this beneficent work—where priestly processions and holy water take the place of quarantine and carbolic acid in fighting cholera—natural selection runs riot and mercifully removes priest and peasant alike. One word in that famous encyclical, in which half its anathemas were hurled against human reason and the sciences,* might have changed all this, but the Church's attitude on these questions is one of the great factors in the selective category.

In this operation of the law of natural selection we have plainly indicated to us the principle with which to fight crime and pauperism. Let us pause for a moment and observe a few of the many ways in which this selective action is working in regard to man, and the suggestions to be derived from it. That the principle of natural selection works in Nature, no intelligent man doubts to-day. The discussion between Prof. Weismann and his adher-

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* See Draper's Conflict between Religion and Science, for convenient reference to these anathemas, p. 350.

ents and the Neo-Lamarckians, as to whether acquired traits are transmitted, only tends to bring out more vividly the simplicity of the law of selective action. Man, as regards himself, has apparently thwarted this law. The humane impulses of man often interfere with selective action; sentimental women and sympathetic magistrates assist in the freeing of criminals who usually find themselves "serving" time by an immediate repetition of their offenses, often in aggravated forms (*vide* Sawtell), having, however, while free, united, out of wedlock, with the lowest of their kind, to perpetuate and possibly accentuate their criminal taint.

The indiscriminate giving of alms and promiscuous feeding of tramps thwarts, in a measure, the work of selective action. Were it not for these interferences the diminution in number of the vicious, incompetent, and lazy would be as marked from year to year as is the decreasing death-rate in cities where sanitary measures are rigorously enforced. What, then, are the unfavorable conditions against which the uneducated vicious class have to contend? In nearly all the essays written on crime and its causes, authors finally unite in agreeing that the slums of a city are the main roots of the evil, or, more correctly, the culture element which fosters this mass of social corruption. Mr. B. O. Flower, in the Arena, says, "The slums of our cities are the reservoirs of physical and moral death, an enormous expense to the state, a constant menace to society, a reality whose shadow is at once colossal and portentous."

As a class, these people live under the worst sanitary conditions, in districts of the city having the highest death-rate. Miss Besant, in a lecture, says: "In London the population is between three and four millions, and of it one person in every five dies in jail, prison, or workhouse. Fifty-five years is the average of citizens of the comfortable class, while twenty-nine is that of the manual laborers. . . . Of one hundred babies born, fifty lie in the cemetery before they are five years old, while of the upper classes but eighteen of every hundred die." (In one city in Europe, where a long series of observations has been made, it is found that the death-rate is higher on the shady side of the street.)* The hot blasts of summer and the chills of winter mark their quota; their ignorance of all medical science leads them to employ a quack, or languish and die without medical aid. If inclined to work, their unrestrained appetite for alcohol shuts them out from all positions of trust, and drives them to the roughest of manual labor often fraught with danger. Their carousals and fights, innutritious and unwholesome foods, violations of all sanitary laws, and many

* Some of the following paragraphs have already been published by the writer in the Boston Herald, under the signature of C. B. D.

other agencies are at work in destroying those least capable of surviving. As among the animals below man, where many individuals best adapted to live perish with the thousands unfitted to survive, so with man does this ruthless but beneficent law take in its grasp many deserving ones, and these are the ones that all the impulses of charity and love should animate us to save.

In combating crime, then, the line of effort should be along those paths indicated by Nature. It is a curious commentary on man's intelligence that, while exercising the selective function on his domestic stock by careful feeding, proper housing, and judicious crossing, and for his plants selecting the best seed, etc., while ruthlessly destroying the noxious weeds, yet when he comes to his own kind he fancies that different laws operate with him, or, swayed by sentiment, looks for different methods to cope with crime. He exterminates the noxious weed, kills his vicious dog, puts under restraint the maniac until cured; no definite terms of banishment will do in these cases, yet he formulates laws in which there is apportioned a definite number of days or years for definite offenses against society!

Colossal organizations, with lavish appropriations, are in the field for the purpose of suppressing crime and pauperism. Until within a few years this great army has been officered by the Church, and plans of campaign have been mapped by it. Slowly the public intelligence is awakening to the fact that these methods have been ridiculously inadequate, as proof exists that crime and pauperism are steadily increasing. The law of indefinite terms of imprisonment for criminals committed for a third offense has been the wisest prison law ever passed, for, by such a law, criminals are the longer prevented from the chance of perpetuating their evil traits; and yet in Massachusetts there are misguided sentimentalists who oppose the enactment of this law.

In this view of the subject the death-penalty—so odious to thousands—may be abolished. The sentence of life-imprisonment may be passed instead, but this must be beyond the interference of any pardoning power. How far the prison-cell may be made attractive, as apartments and corridors in lunatic asylums are made to-day, depends upon the necessity of punitive methods. If punishment, even to flogging, is deemed necessary, criminals must not have offered them such allurements as should lead them to violate the law for the sake of a recommital.

The conditions favorable to crime having been apprehended in the slums of the cities, the law of natural selection having been shown to be as relentlessly at work with man as with the lower animals, it would seem that the line of work is very clearly defined. We are to aid the law of selective action with all our might. Public outdoor relief is in most cities suppressed; indiscriminate charity has still full sway. We are individually and unitedly to suppress the idle, incompetent, and vicious, and at the same time we are to help in every way the industrious and well-intentioned. The congenital criminal and the vagabond we are to imprison for an indefinite time; in this confinement they should be made to work. Paul said that "if any would not work, neither should he eat." Tasks that do not compete with honest labor should be devised for them—breaking stone, sawing and cutting wood for the deserving poor; in certain districts, working on the road, filling malarious tracts, etc.

These are the suppressive and punitive methods, on the one hand; the selective method, on the other hand, is to be found in the erection of wholesome tenement-houses. These should have amusement halls; gardens, if possible; reading-rooms and libraries; halls, where instructive lectures should be given—not on the Holy Land or Babylonian antiquities, but on bread-making, the chemistry of common life, hygiene, and cognate subjects. Talented men and women will be induced to give their services occasionally to entertain or instruct.

Adopting the deed of trust under which the Peabody buildings in London were given,* we should apply the selective action by letting the apartments at the lowest possible rate to all those who are temperate, industrious, and are willing to work, while the vicious and the evil disposed should be rigorously excluded. "Cruel!" you say; but we should recognize the far-reaching mercifulness of this plan in preventing the bringing of vicious children into the world, to live a life of misery and shame, or, if brought in, to find such unfavorable conditions as shall remove them while still young.

Quarantine the evil classes as you would the plague, and plant on good ground the deserving poor. Those who talk about the liberty of the individual before the law are not to include those who are endangering the liberty, perhaps the lives, of others, and are transgressing the law at every step.

Having established the means by which selective action may be brought into play, and in so just a manner, too, that even a vagabond could not complain of its injustice, we are to establish conditions by which the offspring of such colonies may have every chance of continuing in the life of sobriety and industry

* Secondly. It is my intention that now, and for all time, there shall be a rigid exclusion from the management of this fund of any influences calculated to impart to it a character either sectarian, as regards religion, or exclusive in relation to party politics.

Thirdly. It is my wish that the sole qualification for a participation in the benefits of the fund shall be an ascertained and continued condition of life such as brings the individual within the description (in the ordinary sense of the word) of the poor of London, combined with moral character and good conduct as a member of society.

under which they were brought into the world. For this purpose industrial schools, in all lines of work, should be established. The crying need in all trades to-day is for boys who will industrially continue their apprentice term. During this time the boy must be induced to live at home, caring to live there from the attractiveness of the surroundings. Music, lectures, thanksgiving dinners, flowers, etc.—the outflow of compassionate impulses, which make certain penal institutions so alluring to many criminals—will find a better destiny in making pleasanter the lives of deserving tenement dwellers. Cooking schools, training schools for nurses and servants, should be instituted for the girls. With such co-operating appliances, our charity committees, instead of the often despairing tramps through noisome regions, to be deceived by the wary, or horrified at the treachery and lies of others, will have a keen stimulus to seek out the deserving poor; to find those that are willing to work, knowing that, when once rescued and placed on firm ground, they are to remain there —in many cases self-supporting. The response to appeals for aid will be more prompt and bountiful when it is known that worthy ones only are to be helped. The cost of such a project will be great. If private munificence will not do it, cities may.

In Boston, museums of art and of natural history, though free to the public, are, nevertheless, sustained by private help. In New York the State and city are repeatedly called upon for contributions to similar institutions. What municipality of any intelligence has hestitated to spend millions for pure water-supply and sewer system, after it has been clearly demonstrated that local cesspools menace the health of the community by vitiating the local water-supply? It is possible that, when a community fully realizes the moral pollution that comes from the slums, an agitation may result that shall lead a city to construct tenement-houses as it now does its school-houses.* The question is sure to arise, What shall be done with the incompetent, though not necessarily vicious or intemperate? They must not be allowed to starve, surely not; but it is to be observed that, when such incompetents tumble overboard, they make strenuous efforts to save themselves, and if caught in a burning building they appear active, even boisterous, in their attempts to escape. The simplest manual labor is within their power, and for this they should be paid; their chances for quality of food, quantity of tobacco, etc., should depend upon their efforts to help themselves. If they will not work, and insist upon being vagabonds, they come under cognizance of the law, and

* The pauper, the imbecile, the lunatic, and in some cities those afflicted in other ways, are provided for in appropriate public institutions.

their liberty may be abridged, and for an indefinite time if need be. By this curtailment of their freedom *their line of descent is arrested*, and this is the important object to accomplish. In a very inadequate manner, but with illustrations familiar to all, Nature's way has been appealed to as worthy of trial. This is the ringing lesson of natural selection as applied to this great problem, and we commend it, in all earnestness, to those who have the welfare of the submerged classes at heart.

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XVII.—GEOGRAPHY.

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PART I.

1. The Form of the Earth.—Among various rude tribes we find survivals of a primitive idea that the earth is a flat table or disk, ceiled, domed, or canopied by the sky, and that the sky rests upon the mountains as pillars. Such a belief is entirely natural; it conforms to the appearance of things, and hence has entered into various theologies.

In the early civilizations of Egypt and Chaldea it was very fully developed. The Egyptians considered the earth as a table, flat and oblong, the sky being its ceiling; a huge "firmament" of metal. At the four corners of the earth were the pillars supporting this firmament, and on this solid sky were the "waters above the heavens." They believed that, when chaos was taking form, one of the gods by main force raised the waters on high and spread them out over the firmament; that on the under side of this solid vault or ceiling or firmament the stars were suspended to light the earth, and that the rains were caused by the letting down of the waters through its windows. This idea and others connected with it seem to have taken strong hold of the Egyptian priestly caste, thus entering into their theology and sacred science: ceilings of great temples, with stars, constellations, planets, and signs of the zodiac figured upon them, remain to-day as striking evidences of this.

In India and Persia we have theories of geography based upon similar conceptions and embalmed in sacred texts. The Chaldeans also believed that a firmament was spread out over the earth, and that it supported the ocean of celestial waters, from which fell dew and rain.

From these sources came geographical legacies to the Hebrews:

various passages in their sacred books, many of them most noble in conception, and most beautiful in form, regarding the "firmament," the "corners of the earth," the "pillars of heaven," the "waters above the firmament," and the "windows of heaven," point us back to these ancient springs of thought.*

But as civilization was developed, there were evolved, especially among the Greeks, ideas of the earth's sphericity. The Pythagoreans, Plato, and Aristotle especially cherished them. These ideas were vague, they were mixed with absurdities, but they were germ ideas, and even amid the luxuriant growth of theology in the early Christian Church these germs began struggling into life in the minds of a few thinking men, and these men renewed the suggestion that the earth is a globe.†

A few of the larger-minded fathers of the Church, influenced possibly by Pythagorean traditions, but certainly by Aristotle and Plato, were willing to accept this view, but the majority of them took fright at once. To them it seemed fraught with dangers to Scripture, by which, of course, they meant *their inter-*

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* For survivals of the early idea, among the Eskimos, of the sky as supported by mountains, and, among sundry Pacific islanders, of the sky as a firmament or vault of stone, see Tylor, Early History of Mankind, second edition, London, 1870, chap. xi; Spencer, Sociology, vol. i, chap. viii; also Andrew Lang, La Mythologie, Paris, 1886, pp. 68–73. For the early view in India and Persia, see citations from the Vedas and the Zend-Avesta in Lethaby, Architecture, Mysticism, and Myth, chap. i. For the Egyptian view, see Champollion; also, Lenormant, Histoire Ancienne, Maspero, and others. As to the figures of the heavens upon the ceilings of Egyptian temples, see Maspero, Archéologie Egyptienne, Paris, 1890; and for engravings of them, see Lepsius, Denkmäler, vol. i, Bl. 41, and vol. ix, Abth. iv, Bl. 35; also the Déscription de l'Égypte published by order of Napoleon, tome ii, Pl. 14; also Prisse d'Avennes, Art Égyptien, Atlas, tome i, Pl. 35; and especially for a survival at the Temple of Denderah, see Denon, Voyage en Égypte, Planches 129, 130. For the Egyptian idea of "pillars of heaven," as alluded to on the stele of Victory of Thotmes III, in the Cairo Museum, see Ebers, Uarda, ii, 175, note, Leipsic, 1877. For a similar Babylonion belief, see Sayce's Herodotus, Appendix, 403. For the belief of Hebrew scriptural writers in a solid "firmament," see especially Job, xxxviii, 18; also Smith's Bible Dictionary.

† The agency of the Pythagoreans in first spreading the doctrine of the earth's sphericity is generally acknowledged, but the first clear and full utterance of it to the world was by Aristotle. Very fruitful, too, was the statement of the new theory given by Plato in the Timæus; see Jowett's translation, New York edition, 62, c. Also Phædo, pp. 449 *et seq.* See also Grote on Plato's doctrine of the sphericity of the earth; also Sir G. C. Lewis's Astronomy of the Ancients, London, 1862, chap. iii, section i, and note. Cicero's mention of the antipodes, and his reference to the passage in the Timæus are even more remarkable than the original, in that they much more clearly foreshadow the modern doctrine. See his Academic Questions, ii; also Tusc. Quest., i and v, 24. For a very full summary of the views of the ancients on the sphericity of the earth, see Kretchmer, Die physische Erdkunde im christlichen Mittelalter, Wien, 1889, pp. 35 *et seq.;* also, Eicken, Geschichte der mittelälterlichen Weltanschauung, Stuttgart, 1887, Dritter Theil, chap. vi. For citations and summaries, see Whewell, Hist. Induct. Sciences, vol. i, p. 189, and St. Martin, Hist. de la Géog., Paris, 1873, p. 96; also, Leopardi, Saggio sopra gli errori popolari degli antichi, Firenze, 1851, chapter xii, pp. 184 *et seq.*

pretation of Scripture. Among the first who took up arms against it was Eusebius. In view of the New Testament texts indicating the immediately approaching end of the world, he endeavored to turn off this idea by bringing scientific studies into contempt. Speaking of investigators, he said, "It is not through ignorance of the things admired by them, but through contempt of their useless labor, that we think little of these matters, turning our souls to better things." Basil of Cæsarea declared it "a matter of no interest to us whether the earth is a sphere or a cylinder or a disk, or concave in the middle like a fan." Lactantius referred to the ideas of those studying astronomy as "bad and senseless," and opposed the doctrine of the earth's sphericity both from Scripture and reason. St. John Chrysostom also exerted his influence against this scientific belief; and Ephrem Syrus, the greatest man of the old Syrian Church, widely known as the "lute of the Holy Ghost," opposed it no less earnestly.

But the strictly Biblical men of science, such eminent fathers and bishops as Theophilus of Antioch in the second century, Clement of Alexandria in the third, and others in centuries following, were not content with merely opposing what they stigmatized as an old heathen theory; they drew from their Bibles a new Christian theory, to which one church authority added one idea and another another, until it was fully developed. Taking the survival of various early traditions, given in the seventh verse of the first chapter of Genesis, they dwelt on the scriptural declaration that the earth was, at creation, arched over with a solid vault, "a firmament," and to this they added the passage from Isaiah in which it is declared that the heavens are stretched out "like a curtain," and again "like a tent to dwell in." The universe, then, is like a house: the earth is its ground floor, the firmament its ceiling, under which the Almighty hangs out the sun to rule the day, and the moon and stars to rule the night. This ceiling is also the floor of the apartment above, and in this is a cistern, shaped, as one of the authorities says, "like a bathing-tank," and containing "the waters which are above the firmament." These waters are let down upon the earth by the Almighty and his angels through the "windows of heaven." As to the movement of the sun, there was a citation of various passages in Genesis, mixed with metaphysics in various proportions, and this was thought to give ample proofs from the Bible that the earth could not be a sphere.*

* For Eusebius, see the Præp. Ev., xv, 61. For Basil, see the Hexameron, Hom. ix, cited in Peschel, Erdkunde, p. 96, note. For Lactantius, see his Inst. Div., lib. iii, cap. 3; also, citations in Whewell, Hist. Induct. Sciences, London, 1857, vol. i, p. 194, and in St. Martin, Histoire de la Géographie, pp. 216, 217. For the views of St. John Chrysostom Eph. Syrus, and other great churchmen, see Kretschmer as above, chap. i.

In the sixth century this development of theory culminated in what was nothing less than a complete and detailed system of the universe, claiming to be based upon Scripture, its author being the Egyptian monk Cosmas Indicopleustes. Egypt was a great treasure-house of theologic thought to various religions of antiquity, and Cosmas appears to have urged upon the early Church this Egyptian idea of the construction of the world, just as another Egyptian ecclesiastic, Athanasius, urged upon the Church the Egyptian triune idea of the gods ruling the world. According to Cosmas, the earth is a parallelogram, flat, and surrounded by four seas. It is four hundred days' journey long and two hundred broad. At the outer edges of these four seas arise massive walls closing in the whole structure and supporting the firmament or vault of the heavens, whose edges are cemented to the walls. These walls inclose the earth and all the heavenly bodies.

The whole of this theologic-scientific structure was built most carefully and, as was then thought, most scripturally. Starting with the expression applied in the ninth chapter of Hebrews to the tabernacle in the desert, Cosmas insists, with other interpreters of his time, that it gives the key to the whole construction of the world. The universe is, therefore, made on the plan of the Jewish tabernacle—box-like and oblong. Going into details, he quotes the sublime words of Isaiah: "It is He that sitteth upon the circle of the earth; . . . that stretcheth out the heavens like a curtain, and spreadeth them out like a tent to dwell in"; and the passage in Job, which speaks of the "pillars of heaven." He works all this into his system, and reveals, as he thinks, treasures of science.

This vast box is divided into two compartments, one above the other. In the first of these, men live and stars move; and it extends up to the first solid vault, or firmament, above which live the angels, a main part of whose business it is to push and pull the sun and planets to and fro. Next, he takes the text, "Let there be a firmament in the midst of the waters, and let it divide the waters from the waters," and other texts from Genesis; to these he adds the text from the Psalms, "Praise him, ye heaven of heavens, and ye waters that be above the heavens"; then casts all these growths of thought into his crucible together, and finally brings out the theory that over this first vault is a vast cistern containing "the waters." He then takes the expression in Genesis regarding the "windows of heaven" and establishes a doctrine regarding the regulation of the rain, to the effect that the angels not only push and pull the heavenly bodies to light the earth, but also open and close the heavenly windows to water it.

To understand the surface of the earth, Cosmas studies the table of show-bread in the Jewish tabernacle. The surface of this table proves to him that the earth is flat, and its dimensions prove that the earth is twice as long as broad; its four corners symbolize the four seasons; the twelve loaves of bread, the twelve months; the hollow about the table proves that the ocean surrounds the earth. To account for the movement of the sun, Cosmas suggests that at the north of the earth is a great mountain, and that at night the sun is carried behind this; but some of the commentators ventured to express a doubt here; they thought that the sun was pushed into a great pit at night and pulled out in the morning.

Nothing can be more touching in its simplicity than Cosmas's summing up of his great argument. He declares, "We say therefore with Isaiah that the form of the heaven that embraces the universe is that of a vault, with Job that it is joined to the earth, and with Moses that the length of the earth is greater than its breadth." The treatise closes with rapturous assertions that not only Moses and the prophets, but also angels and apostles, agree to the truth of his doctrine, and that at the last day God will condemn all who do not accept it.

Although this theory was universally considered as drawn from Scripture, it was really, as we have seen, the result of an evolution of theological thought begun long before the texts on which it nominally rested were written. It was not at all strange that Cosmas, Egyptian as he was, should have received this old Nile-born doctrine, as we see it indicated to-day in the structure of Egyptian temples, and that he should have developed it by the aid of the Jewish Scriptures. But the theological world knew nothing of its more remote pagan evolution; it was received as virtually inspired, and was soon regarded as a fortress of scriptural truth. Some of the foremost men in the Church devoted themselves to buttressing it with new texts and throwing about it new outworks of theological reasoning; the great body of the faithful considered it a direct gift from the Almighty.*

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* For a notice of the views of Cosmas in connection with those of Lactantius, Augustine, St. John Chrysostom, and others, see Schoell, Histoire de la Littérature Grecque, vol. vii, p. 37. The main scriptural passages referred to are as follows: (1) Isaiah xl, 22; (2) Genesis i, 6; (3) Genesis vii, 11; (4) Exodus xxiv, 10; (5) Job xxvi, 11, and xxxvii, 18; (6) Psalm cxlviii, 4, and civ, 9; (7) Ezekiel i, 22–26. For Cosmas's theory see Montfaucon, Collectio Nova Patrum, Paris, 1706, vol. ii, p. 188; also pp. 298, 299. The text is illustrated with engravings showing walls and solid vault (firmament), with the whole apparatus of "fountains of the great deep," "windows of heaven," angels, and the mountain behind which the sun is drawn. For reduction of one of them see Peschel, Geschichte der Erdkunde, p. 98; also article "Maps," in Knight's Dictionary of Mechanics, New York, 1875. For a good discussion of Cosmas's ideas, see Santarem, Hist. de la Cosmographie, vol. ii, pp. 8 *et seq.*, and for a very thorough discussion of its details, Kretschmer, as above. For still another theory, very droll, and thought out on similar principles, see Mungo Park, cited in De Morgan, Paradoxes, 309. For Cosmas's joyful summing up, see Montfaucon,

From this old conception of the universe as a sort of house, with heaven as its upper story and the earth as its ground floor, flowed important theological ideas into heathen, Jewish, and Christian mythologies. Common to them all are legends regarding attempts of mortals to invade the upper apartment from the lower. Of such are the Greek legends of the Aloidae who sought to reach heaven by piling up mountains, and were cast down; the Chaldean and Hebrew legends of the wicked who at Babylon sought to build "a tower whose top may reach heaven," which Jehovah went down from heaven to see, and which he brought to naught by the "confusion of tongues"; the Hindoo legend of the tree which sought to grow into heaven and which Brahma blasted; and the Mexican legend of the giants who sought to reach heaven by building the Pyramid of Cholula, and who were overthrown by fire from above.

Myths having this geographical idea as their germ developed in luxuriance through thousands of years. Ascensions to heaven and descents from it, "translations," "assumptions," "annunciations," mortals "caught up" into it and returning, angels flying between it and the earth, thunderbolts hurled down from it, mighty winds issuing from its corners, voices speaking from the upper floor to men on the lower, temporary openings of the floor of heaven to reveal the blessedness of the good, "signs and wonders" hung out from it to warn the wicked, interventions of every kind, from the heathen gods coming down on every sort of errand, and Jehovah coming down to walk in Eden in the cool of the day, to St. Mark swooping down into the market-place of Venice to break the shackles of a slave—all these are but features in a vast evolution of myths arising largely from this geographical germ.

Nor did this evolution end here. Naturally, in this view of things, if heaven was a loft, hell was a cellar; and if there were ascensions into one, there were descents into the other. Hell being so near, interferences by its occupants with the dwellers of the earth just above were constant and form a vast chapter in mediæval literature. Dante made this conception of the location of hell still more vivid, and we find some forms of it serious barriers to geographical investigation. Many a bold navigator, who was quite ready to brave pirates and tempests, trembled at the thought of tumbling with his ship into one of the openings into hell which a wide-spread belief placed in the Atlantic at some unknown distance from Europe. This terror of the sailors was one of the main obstacles in the great voyage of Columbus. In an

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Collectio Nova Patrum, vol. ii, p. 255. For the Egyptian Trinitarian views, see Sharpe, History of Egypt, vol. i, pp. 94, 102.

Anglo-Saxon tract, giving science the form of a dialogue, occur the following question and answer: "Why is the sun so red in the evening?" "Because he looketh down upon hell."

But the ancient germ of scientific truth in geography still lived, and a hundred years after Cosmas it gets new life from a great churchman of southern Europe, Isidore of Seville, who, however fettered by the dominant theology in many other things, braved it in this. In the eighth century a similar declaration is made in the north of Europe by another great church authority, Bede. Against the new life thus given to the old truth, the sacred theory struggled long and vigorously but in vain. Eminent authorities in later ages, like Albert the Great, St. Thomas Aquinas, Dante, and Vincent of Beauvais, felt obliged to accept the doctrine of the earth's sphericity, and as we approach the modern period we find its truth acknowledged by the vast majority of thinking men.*

2. The Delineation of the Earth.—Every great people of antiquity, as a rule, regarded its own central city or most holy place as necessarily the center of the earth.

The Chaldeans held that their "holy house of the gods" was the center. The Egyptians sketched the world under the form of a human figure, in which Egypt was the heart, and the center of it, Thebes. For the Assyrians, it was Babylon; for the Hindoos, it was Mount Meru; for the Greeks, so far as the civilized world was concerned, Olympus or the temple at Delphi; for the modern Mohammedans, it is Mecca and its sacred stone; the Chinese, to this day, speak of their empire as the "middle kingdom." It was in accordance, then, with a simple tendency of human thought that the Jews believed the center of the world to be Jerusalem.

The book of Ezekiel speaks of Jerusalem as in the middle of the earth, and all other parts of the world as set around the holy city. Throughout the "ages of faith" this was very generally accepted as a direct revelation from the Almighty regarding the earth's form. St. Jerome, the greatest authority of the early Church upon the Bible, declared, on the strength of this utterance of the prophet, that Jerusalem must stand at the earth's center; in the ninth century Archbishop Rabanus Maurus reiterated the same argument; in the eleventh century, Hugh of St. Victor gave to the doctrine another scriptural demonstration; and Pope Urban, in his great sermon at Clermont urging the Franks to the crusade, declared, "Jerusalem is the middle point of the earth";

* For a discussion of the geographical views of Isidore and Bede, see Santarem, Cosmographie, vol. i, pp. 22–24. For the gradual acceptance of the idea of the earth's sphericity after the eighth century, see Kretschmer, pp. 51 *et seq.*, where citations from a multitude of authors are given.

in the thirteenth century, another of the mediæval Church authorities, Cæsar of Heisterbach, declared, "As the heart in the midst of the body, so is Jerusalem situated in the midst of our inhabited earth"; "so it was that Christ was crucified at the center of the earth." Dante accepted this view of Jerusalem as a certainty and wedded it to immortal verse.

Ezekiel's statement thus became the standard of orthodoxy to early map-makers. The map of the world at Hereford Cathedral, the maps of Andrea Bianco, Marino Sanuto, and a multitude of others fixed this view in men's minds, and doubtless helped during many generations to discourage any scientific statements tending to unbalance this geographical center supposed to be revealed in Scripture.*

Nor did mediæval thinkers rest with this conception. In accordance with the dominant view that physical truth must be sought by theological reasoning, the idea was evolved that not only the site of the cross on Calvary marked the geographical center of the world, but that on this very spot had stood the tree which bore the forbidden fruit in Eden. Thus was geography made to reconcile all parts of the great theologic plan. This doctrine was hailed with joy by multitudes; and we find in the works of mediæval pilgrims to Palestine, again and again, evi-

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* For the beliefs of various nations of antiquity that the earth's center was in their most sacred place, see citations from Maspero, Charton, Sayce, and others in Lethaby, Architecture, Mysticism, and Myth, chap. iv. As to the Greeks, we have typical statements in the Eumenides of Æschylus, where the stone on the altar at Delphi is repeatedly called "the earth's navel"—which is precisely the expression used regarding Jerusalem in the Septuagint translation of Ezekiel (see note below). The proof texts on which the mediæval geographers mainly relied as to the form of the earth were Ezekiel, v, 5, and xxxviii, 12. The progress of geographical knowledge evidently caused them to be softened down somewhat in our King James's version; but the first of them reads, in the Vulgate, "*Ista est Hierusalem, in medio gentium posui eam et in circuitu ejus terræ*"; and the second reads, in the Vulgate, "*in medio terræ*," and in the Septuagint, ἐπὶ τὸν ὀμφαλὸν τῆς γῆς. That the literal center of the earth was understood, see proof in St. Jerome, Commentar. in Ezekiel, lib. ii; and for general proof, see Leopardi, Saggio sopra gli errori popolari degli antichi, pp. 207, 208. For Rabanus Maurus, see his De Universo, lib. xii, cap. 4, in Migne, tome cxi, p. 339. For Hugh of St. Victor, see his De Situ Terrarum, cap. ii. For Dante's belief, see Inferno, canto xxxiv, 112–115:

"E se' or sotto l'emisperio giunto,
Ch' è opposito a quel che la gran secca
Coverchia, e sotto il cui colmo consunto
Fu l'uom che nacque e visse senza pecca."

For orthodox geography in the middle ages, see Wright's Essays on Archæology, vol. ii, chapter on the map of the world in Hereford Cathedral; also the rude maps in Cardinal d'Ailly's Ymago Mundi; also copy of maps of Marino Sanuto and others in Peschel, Erdkunde, p. 210; also Münster, Fac Simile dell' Atlante de Andrea Bianco, Venezia, 1869. And for discussions of the whole subject, see Santarem, vol. ii, p. 295, vol. iii, pp. 71, 183, 184, and elsewhere. For a brief summary with citations, see Eicken, Geschichte, etc., pp. 622, 623.

dence that this had become precious truth to them, both in theology and geography.*

Nor was this the only misconception which forced its way from our sacred writings into mediæval map-making; two others were almost as marked.

First of these was the vague terror inspired by Gog and Magog. Few passages in the Old Testament are more sublime than the denunciation of these great enemies by Ezekiel: and the well-known statement in the Apocalypse fastened the Hebrew feeling regarding them with a new meaning into the mind of the early Church: hence it was that the mediæval map-makers took great pains to delineate these monsters and their habitations on the maps. For centuries no map was considered orthodox which did not show them.

The second conception was derived from the frequent mention in our sacred books of the "four winds." Hence came a vivid belief in their real existence and their delineation on the maps, generally as colossal heads with distended cheeks, blowing vigorously toward Jerusalem.

Even at a period after these conceptions had mainly disappeared we find here and there evidences of the difficulty men found in giving up the scriptural idea of direct personal interference by agents of Heaven in the ordinary phenomena of Nature: thus in a noted map of the sixteenth century representing the earth as a sphere, there is at each pole a crank, with an angel laboriously turning the earth by means of it.†

* For the site of the cross on Calvary, as the point where stood "the tree of the knowledge of good and evil" in Eden, at the center of the earth, see various Eastern travelers cited in Tobler; but especially the travels of Bishop Arculf in the Holy Land in Wright's Early Travels in Palestine, p. 8; also, Travels of Saewulf, ibid., p. 38; also, Sir John Maundeville, ibid., pp. 166, 167; and for one narrative in which the idea was developed into an amazing mass of pious myths, see Pilgrimage of the Russian Abbot Daniel, edited by Sir C. W. Wilson, London, 1885, p. 14. (The passage deserves to be quoted as an example of myth-making; it is as follows: "At the time of our Lord's crucifixion, when he gave up the ghost on the cross, the veil of the temple was rent, and the rock above Adam's skull opened, and the blood and water which flowed from Christ's side ran down through the fissure upon the skull, thus washing away the sins of men.")

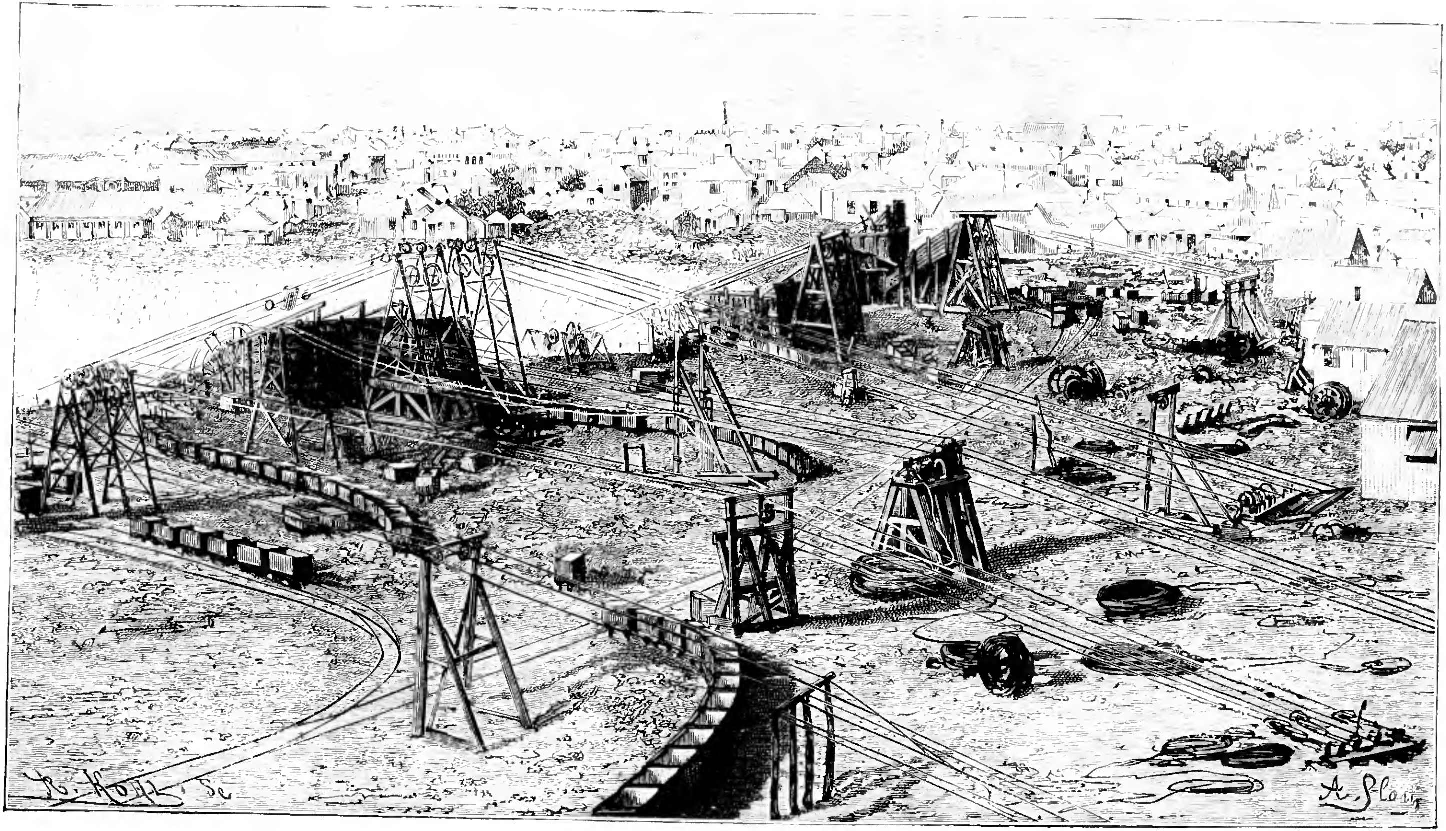
† For Gog and Magog, see Ezekiel, chaps. xxxviii and xxxix, and Rev. xx, 8; and for the general subject, Toy, Judaism and Christianity, Boston, 1891, pp. 373, 374. For maps showing these two great terrors, and for geographical discussion regarding them, see Lelewel, Géog. du Moyen Age, Bruxelles, 1850, Atlas; also Ruge, Gesch. des Zeitalters der Entdeckungen, Berlin, 1881, pp. 78, 79; also Peschel's Abhandlungen, pp. 28–35, and Gesch. der Erdkunde, p. 210. For representations on maps of the "Four Winds," see Charton, Voyageurs, tome ii, p. 11; also Ruge as above, pp. 324, 325; also, for a curious mixture of the scriptural four winds with the classical winds issuing from the bags of Æolus, see a map of the twelfth century in Léon Gautier, La Chevalerie, p. 153; and for maps showing additional winds, see various editions of Ptolemy. For a map with angels turning the earth by means of cranks at the poles, see Grynæus, Novus Orbis, Basileæ, 1537.

THE DIAMOND INDUSTRY AT KIMBERLEY.*

By LORD RANDOLPH CHURCHILL.

NOTHING in the external appearance of Kimberley suggests either its fame or its wealth. A straggling, hap-hazard connection of small, low dwellings, constructed almost entirely of corrugated iron or of wood, laid out with hardly any attempt at regularity, and without the slightest trace of municipal magnificence, is the home of the diamond industry. It seems that when the diamonds were first discovered, some twenty years ago, many thousands of persons settled down suddenly on the spot like a cluster of swarming bees, and established themselves anyhow as best they could in the most rough and primitive fashion, never dreaming but that the yield of diamonds would be of limited extent and of short duration, that their fortunes would be rapidly acquired, and that they would pass as rapidly away from the place, having exhausted all its wealth-producing resources. The reverse has proved to be the case. The diamondiferous resources of Kimberley are now known to be practically inexhaustible, but the amalgamation of the mines has restricted employment and checked immigration, and the town still preserves, and probably will always preserve, its transitory and rough-and-ready appearance. There are, however, a number of excellent shops, and there are few articles of necessity, of convenience, or of luxury which can not here be purchased. A most comfortable and hospitable club, an admirably laid-out and well-arranged race-course testify to the thoroughly English character of the settlement. At Kimberley the diamond is everything, and the source and method of its production claim more than a passing mention. My first visit was to the offices of the De Beers Company, which company represents the amalgamated interests of the De Beers, Kimberley, Bultfontein, Du Toits Pan, and other smaller mines. The amalgamation was the work of Mr. Cecil Rhodes, and it was this great work, accomplished in the teeth of unheard-of difficulties and almost insurmountable opposition, representing the conciliation and unification of almost innumerable rival jarring and conflicting interests, which revealed to South Africa that it possessed a public man of the first order. The scale of the company's operations is stupendous. On a capital of nearly £8,000,000 of debenture and share stock it has paid, since its formation in 1888 up to March, 1890, interest at the rate of 5½ per cent, and an annual dividend of 20 per cent. In the same period it has given out some 2,500,000

* From Men, Mines, and Animals of South Africa. By Lord Randolph Churchill. New York: D. Appleton & Co., 1892.



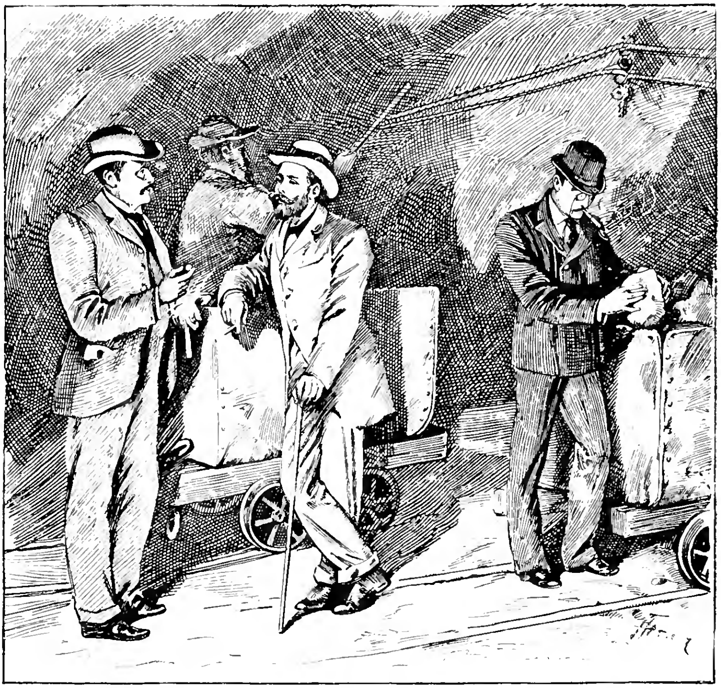
Kimberley and its Diamond Mine. (From Reclus's The Earth and its Inhabitants.)

carats of diamonds, realizing by sale over £3,500,000, produced by washing some 2,700,000 loads of blue ground. Each load represents three quarters of a ton, and costs in extracting about 8*s.* 10*d.* per load, realizing a profit of 20*s.* to 30*s.* per carat sold. The annual amount of money paid away in interest and dividends exceeds £1,300,000. The dividends might have been much larger, but the

Classified for Shipment at Kimberley.

policy of the present board of directors appears to be to restrict the production of diamonds to the quantity the world can easily absorb, to maintain the price of the diamonds at a fair level from 28*s.* to 32*s.* per carat, and, in order the better to carry out this policy, to accumulate a very large cash reserve. I believe that the reserve already accumulated amounts to nearly £1,000,000, and that this amount is to be doubled in the course of the next year or two, when the board will feel that they have occupied for their shareholders a position unassailable by any of the changes and chances of commerce. In the working of the mine there are employed about 1,300 Europeans and 5,700 natives. The wages paid range high, and figures concerning them may interest the English artisan. Mechanics and engine-drivers receive from £6 to £7 per week, miners from £5 to £6, guards and tally-men from £4 to £5; natives in the underground works are paid from 4*s.* to 5*s.* per day. In the work on the "floors," which is all surface work, overseers receive from £3 12*s.* to £4 2*s.*, machine-men and assorters from £5 to £6, and ordinary native laborers from 17*s.* 6*d.* to 21*s.* per week. In addition, every employé on the "floors" has a percentage on the value of diamonds found by himself, the white employés receiving 1*s.* 6*d.*, and the natives 3*d.*, per carat. Nearly double these amounts are paid for stones found in the mines.

Mr. Gardner Williams, the eminent mining engineer who occupies the important post of general manager to the De Beers Company, was kind enough to accompany me all over the mines, and to explain in detail the method of operation. The De Beers and the Kimberley mines are probably the two biggest holes which greedy man has ever dug into the earth, the area of the former at the surface being thirteen acres, with a depth of 450 feet, the area and depth of the latter being even greater. These mines are no



Mr. Gardner Williams. Lord Randolph Churchill. Captain Williams.

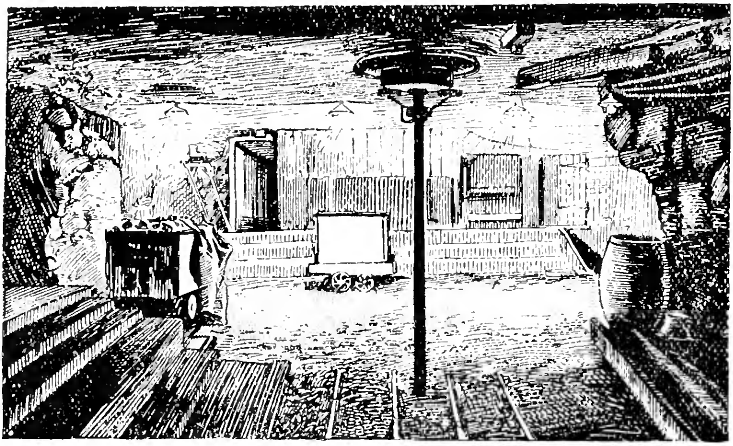
In the Rock Shaft of the De Beers Diamond Mine at a Depth of Nine Hundred Feet.

longer worked from the surface, but from shafts sunk at some distance from the original holes, and penetrating to the blue ground by transverse drivings at depths varying from 500 to 1,200 feet. The blue ground, when extracted, is carried in small iron trucks to the "floors." "These are made by removing the bush and grass from a fairly level piece of ground; the land is then rolled and made as hard and as smooth as possible. These 'floors' are about 600 acres in extent. They are covered to the depth of about a foot with the blue ground, which for a time remains on them without much manipulation. The heat of the sun and moisture soon have a wonderful effect upon it. Large pieces which were as hard as ordinary sandstone when taken from the mine, soon commence to crumble. At this stage of the work, the winning of the diamonds assumes more the nature of farming than of mining; the ground is continually harrowed to assist pulverization by exposing the larger pieces to the action of the sun and rain. The blue ground from Kimberley mine becomes quite well pulverized in three months, while that from De Beers requires double that time. The longer the ground remains exposed, the better it is for washing." * The process of exposure being completed, the blue ground is then carried to very large, elaborate, and costly washing machines, in which, by means of the action of running water, the diamonds are separated from the ordinary earth. It may be mentioned that in this process one hundred loads of blue ground are concentrated into one load of diamondiferous stuff. Another machine, the "pulsator," then separates this latter stuff, which appears to be a mass of blue and dark pebbles of all shapes, into four different sizes, which then pass on to the assorters. "The assorting is done on tables, first while wet by white men, and then dry by natives." † The assorters work with a kind of trowel, and their accuracy in detecting and separating the diamond from the eight different kinds of mineral formations which reach them is almost unerring. "The diamond occurs in all shades of color from deep yellow to a blue white, from deep brown to light brown, and in a great variety of colors, green, blue, pink, brown, yellow, orange, pure white, and opaque." ‡ The most valuable are the pure white and the deep orange. "The stones vary in size from that of a pin's head upward; the largest diamond yet found weighed 428½ carats. It was cut and exhibited at the Paris Exhibition, and after cutting weighed 228½ carats. "After assorting, the diamonds are sent daily to the general office under an armed escort and delivered to the valuators in charge of the diamond department. The first operation is to clean the diamonds of any extraneous matter by boiling them in a mixture of nitric and sulphuric acids. When cleaned they are carefully assorted again in respect of size, color, and purity." # The room in the De Beers office where they are then displayed offers a most striking sight. It is lighted by large windows, underneath which runs a broad counter covered with white sheets of paper, on which are laid out innumerable glistening heaps of precious stones of indescribable variety. In this room are concentrated some 60,000 carats, the daily production of the Consolidated Mine being about 5,500 carats. "When the diamonds have been valued they are sold in parcels to local buyers, who represent the leading

* Report, 1890, General Manager, De Beers. † Ibid. ‡ Ibid. # Ibid.

diamond merchants of Europe. The size of a parcel varies from a few thousand to tens of thousands of carats; in one instance, two years ago, nearly a quarter of a million of carats were sold in one lot to one buyer." *

The company sustain a considerable loss annually, estimated now at from 10 to 15 per cent, by diamonds being stolen from the mines. To check this loss, extraordinary precautions have been resorted to. The natives are engaged for a period of three months, during which time they are confined in a compound surrounded by a high wall. On returning from their day's work, they have to strip off all their clothes, which they hang on pegs in a shed. Stark naked, they then proceed to the searching-room, where their mouths, their hair, their toes, their armpits, and every

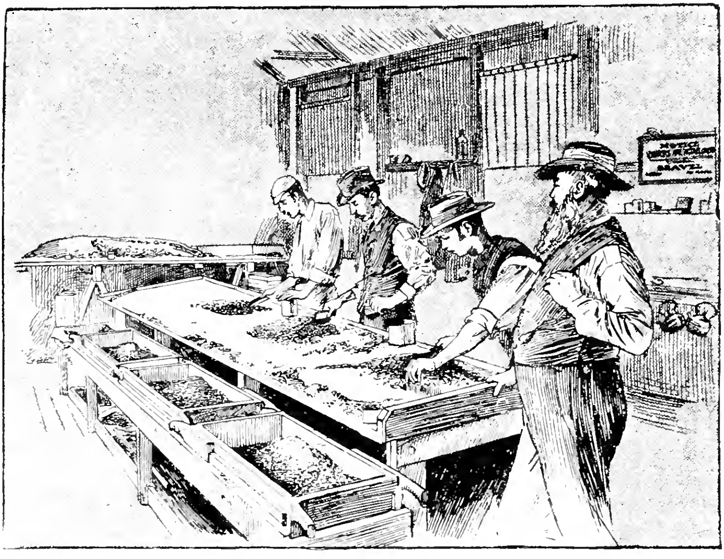


In the Eight-Hundred-Feet Level of the De Beers Diamond Mine.

portion of their bodies are subjected to an elaborate examination. White men would never submit to such a process, but the native sustains the indignity with cheerful equanimity, considering only the high wages which he earns. After passing through the searching-room, they pass, still in a state of nudity, to their apartments in the compound, where they find blankets in which to wrap themselves for the night. During the evening the clothes which they have left behind them are carefully and minutely searched, and are restored to their owners in the morning. The precautions which are taken a few days before the natives leave the compound, their engagement being terminated, to recover diamonds which they may have swallowed, are more easily imagined than described. In addition to these arrangements, a law of exceptional rigor punishes illicit diamond buying, known in

* Report, 1890, General Manager, De Beers.

the slang of South Africa as I. D. B.ism. Under this statute, the ordinary presumption of law in favor of the accused disappears, and an accused person has to prove his innocence in the clearest manner, instead of the accuser having to prove his guilt. Sentences are constantly passed on persons convicted of this offense ranging from five to fifteen years. It must be admitted that this tremendous law is in thorough conformity with South African sentiment, which elevates I. D. B.ism almost to the level, if not above the level, of actual homicide. If a man walking in the streets or in the precincts of Kimberley were to find a diamond and were not immediately to take it to the registrar, restore it to him, and to have the fact of its restoration registered, he would be liable to a punishment of fifteen years' penal servitude. In order to prevent illicit traffic, the quantities of diamonds produced by the mines are reported to the detective department both



SORTING GRAVEL FOR DIAMONDS AT KIMBERLEY.

by the producers and the exporters. All diamonds, except those which pass through illicit channels, are sent to England by registered post, the weekly shipments averaging from 40,000 to 50,000 carats. The greatest outlet for stolen diamonds is through the Transvaal to Natal, where they are shipped by respectable merchants, who turn a deaf ear to any information from the diamond fields to the effect that they are aiding the sale of stolen property.* The most ingenious ruses are resorted to by the illicit

* Report, 1890, General Manager, De Beers.

dealers for conveying the stolen diamonds out of Kimberley. They are considerably assisted by the fact that the boundaries of the Transvaal and of the Free State approach within a few miles of Kimberley, and once across the border they are comparatively safe. Recently, so I was informed, a notorious diamond thief was seen leaving Kimberley on horseback for the Transvaal. Convinced of his iniquitous designs, he was seized by the police on the border and thoroughly searched. Nothing was found on him, and he was perforce allowed to proceed. No sooner was he well across the border, than he, under the eyes of the detective, deliberately shot and cut open his horse, extracting from its intestines a large parcel of diamonds, which, previous to the journey, had been administered to the unfortunate animal in the form of a ball.

The De Beers directors manage their immense concern with great liberality. A model village, called Kenilworth, within the precincts of the mines, affords most comfortable and healthy accommodation for several of the European employés. Gardens are attached to cottages, and the planting of eucalyptus, cypress, pine, and oak, as well as a variety of fruit trees, has been carried to a considerable extent. A very excellent club-house has also been built, which includes, besides the mess-room and kitchen, a reading-room, where many of the monthly papers and magazines are kept, together with six hundred volumes from the Kimberley Public Library. There is also a billiard-room, with two good tables given by two of the directors. A large recreation-ground is in the course of construction. Within the compound where the native laborers are confined is a store where they can procure cheaply all the necessaries of life. Wood and water are supplied free of charge, and a large swimming-bath is also provided, but I did not learn if the natives made much use of it. All sick natives are taken care of in a hospital connected with the compound, where medical attendance, nurses, and food are supplied gratuitously by the company. I should not omit to mention that the entire mine, above and under ground, is lighted by electricity. There are ten circuits of electric lamps for De Beers and Kimberley mines. They consist of fifty-two arc lamps of 1,000 candle-power each, and 691 glow lamps of sixteen and sixty-four candle-power each, or a total illuminating power of 63,696 candles. There are, moreover, thirty telephones connecting the different centers of work together, and over eighty electric bells are used for signaling in shafts and on haulages. Such is this marvelous mine, the like of which I doubt whether the world can show. When one considers the enormous capital invested, the elaborate and costly plant, the number of human beings employed, and the object of this unparalleled concentration of effort, curious reflections occur. In all other mining distinctly profitable objects are sought, and purposes are carried out beneficial generally to mankind. This remark would apply to gold mines, to coal mines, to tin, copper, and lead mines; but at the De Beers mine all the wonderful arrangements I have described above are put in force in order to extract from the depths of the ground, solely for the wealthy classes, a tiny crystal to be used for the gratification of female vanity in imitation of a lust for personal adornment essentially barbaric if not altogether savage.

STATE INTERVENTION IN SOCIAL ECONOMY.

BY M. ANATOLE LEROY BEAULIEU.

THE Church has now a social doctrine which some Catholics assume to impose on the faith as a teaching of infallible authority. The papacy, turning toward the democracy, has presented a programme of social reform;* and in the face of the courtiers and of the people has declared to the age that the first article of the social reform must be a moral reform. This is a hard word to many ears, and the wise men of the world hearing it shake their heads and pass on. "Is that all you have to tell us?" the children of the age seem to say; "we have other things to do than stop to hear your wise advice. The time for these moral lessons has passed. Our progressive age wants something newer and more substantial, which it will hardly go for to Rome." Pope Leo XIII seems to have anticipated these sarcastic reflections, and his language is in marked distinction from that of his predecessors, by his not talking of religion and morals alone. He knows that this is not enough for the unbelieving masses; and after having reminded us that God alone can save us, he does not refuse to consider the means proposed by the wisdom or imagination of men for the pacification of contemporary society; and he examines these means with a kindly and patient solicitude, not as a mystic bent on exposing their vanity, but as a practical man anxious to find early solutions, and sincerely desiring to ameliorate the material position of the working classes.

Two ways to this result are open to our society: one by the intervention of the state, the other by special associations. Leo XIII has examined them both very carefully; and we purpose to see what he thinks of the first, the broadest one, on which the masses would cast themselves as if by instinct. Is the Church in favor of the intervention of the state or against it? The ma-

* In the Labor Encyclical.

jority believe that, whether we be Catholic or heterodox, we must be for one or the other; that there can be no middle ground. But as a Catholic, Albert de Mun, has remarked, nothing so quickly leads to inexactness as the passion for arranging men and doctrines in separate groups and designating them by special terms. Such a classification would be especially fallacious in this case; for I do not know of any persons who utterly reject the intervention of the state. In one sense everybody is an interventionist, for we all agree with Leo and the theologians that it is the state's duty to protect the rights of every one, and that the repression of abuses belongs to it. But where does the function of protecting individuals which devolves upon the state begin, where does it end, over what does it extend? We do not all form the same conception of the attributes of the public power. This divergence is more important to our society than the contests of republicans and monarchists or the quarrels of opportunists and radicals. This, and not fastidious controversies on forms of government or the validity of constitutions, constitutes the vital question for modern nations.

The doctrine of *laissez-faire*, or let alone, has lately enjoyed in some states an authority which it does not deserve. It was once a device of freedom, but it was a negative device, and neither science nor society can rest wholly on a negation. Those who have tried to refer all economical science to it have only succeeded in discrediting political economy and economists. The let-alone, applied where it does not belong—to the work of children and girls in the shop or the mine, for example—becomes inhuman and murderous, and, as it were, the accomplice of the criminal exploitation of misery and vice. Hence it has gone into disfavor; and, as often happens to our human weakness, which straightens itself on one side only to lean over on the other, the inevitable reaction against the famous maxim of Gournay has passed just bounds.

This phrase was applied by those who invented it to industry, commerce, and labor. In demanding the let-alone, Gournay and the economists of the eighteenth century claimed for every Frenchman the right to make, sell, buy, and carry agricultural and industrial products freely. The demand was a protest against the minute and ruinous regulations of the old *régime*, against the pretension to hold in leading-strings everything in the kingdom that lived by labor. In this sense the *laissez-faire* is eternally true. Of all the phrases pronounced in France, it was one of those which resounded the farthest—the one, perhaps, that has put French words upon the largest number of human lips. The brief maxim, of which few know the author, has made the tour of the globe, and has contributed a good share to the renovation of the world. To it is due the emancipation of labor, and the development by that of public wealth in the nineteenth century. Because a generation or two, in two or three countries, have abused it, is no reason for forgetting its services, especially at a time when we see the old chains brought back, or new ones in forging, with which to load industry and labor.

The third part of the Pope's Encyclical is devoted to this important subject, and, after touching upon several aspects of the question, he concludes that "equity requires that the state concern itself with the workmen, and so act that, of all the goods they secure for society, a suitable part shall return to them, such as habitation and clothing, and that they may live at the cost of the fewest pains and privations. Whence it follows that the state should favor all that closely or remotely appears calculated to ameliorate their lot." Such is the Pope's theory; but this is of less importance than the practice. If the state has a right to intervene, what should be the conditions and what the limits of its intervention? The Pope is very careful in expressing himself on this point, and declares that intervention ought not to be exercised except when it is absolutely indispensable, or when there is no other means of opposing the evils with which society is afflicted, and should be limited to seeing that every individual's rights are respected and preserved. If it comes to pass, he says, that workmen, abandoning their work or suspending it by strikes, menace public tranquillity; that the natural bonds of the family are relaxed among them; that religion is violated by employers not leaving them time to perform their duties of worship; if, by promiscuous mingling of the sexes or other excitations to vice, the factories imperil morality; if the employer imposes iniquitous burdens on the workmen, or dishonors their manhood by unworthy and degrading conditions; if he endangers their health by excessive tasks, disproportionate to their sex or age—in such cases it is necessary to use, within certain limits, the force and authority of the laws. In the protection of private rights, the Pope adds, the state should concern itself especially with the weak and indigent; and he qualifies his whole expression by saying that the law should undertake nothing beyond what is necessary to repress abuses and remove dangers.

The idea of the state as a Providence appears to us not only false and pernicious from the social point of view; it seems to have about it, too, in these days, something unchristian: it has a pagan flavor, a scent of sacrilegious usurpation. We discern in it a pretension of the state to erect itself into a divinity which shall take the place of the invisible God and arrogate to itself his function on the earth. It is as if there were a revolution in the government of the universe, as if another Providence were coming in to take the place of the old one and dethrone him. We know that the old churchmen saw something divine in the origin and nature of the state; but then there were in those days relations between the Church and the state that exist no longer. The kings and emperors of the middle ages never dreamed habitually of deifying themselves, or of attributing to themselves in their own personalities a divine mission. Even in its highest pretensions and most impudent usurpations the state of the old *régime* was never ashamed to bow before God, it acknowledged that it held its power from him, and considered itself under obligations to make his laws respected. The Church never saw an adversary or a rival in it; if it rebelled occasionally against the supremacy of the ecclesiastical power, the Church could always hope to bring it back to docility and obedience.

But we mistrust the modern state, both as Christians and as citizens. This modern state, monarchical or republican; the bureaucratic state, with a hundred arms reaching everywhere; the elective state, headless or many-headed, changing, incoherent, capricious, constantly inclined to usurp the functions of the family, of private societies, of individuals—we are afraid to extend its competence beyond bounds. We know it too well to give ourselves up to it. We know by experience how heavy and clumsy its hand is; how violent, rough, arbitrary, and tyrannical are its processes, and how presumptuous and costly are its methods. The Church itself knows something of its character and proceedings. St. Thomas of Aquinas said the state was the servant of God for good. But is it God whose minister the contemporary state is? Even when it does not sin by doctrinal presumption, or by anti-religious intolerance, or by usurpation of authority over the family, the state seems to us morally incapable of assuming the high mission which some of the sons of the Church seem to claim for it. It is inspired neither with Christian law nor with the law of God, nor with the ideal justice which such persons prescribe as its guides. Its law and rule are not justice, but electoral interests. Instead of being, as it is invited to be, an impartially serene authority, lifted above all classes and providing equitably for all, the state which we know and whose workings we witness is essentially partial. The child of government by party, it is, we might say, partial by derivation. Instead of the traditional balances of justice, it has two weights and two measures in everything. It has none of the qualities of an earthly Providence: not foresight, or intelligence, or equity, or wisdom. It is always ready to encroach upon a domain which is not its own, and in every direction; it is careless of the rights of others, and recognizes hardly any but those which it has established; it assumes to be the only law-maker, and imagines that it creates right. It believes that everything is permitted it, and vaunts itself on subjecting everything. It wants to be all, and its will is changing, violent, and weak by turns, like the passionate majorities and the ignorant crowds whence it emanates; and so slight is our confidence in the state that its mobility reassures us more than it scares us.

Yes, we distrust the state, whatever its name or shape; we distrust its prudence, its lights, its doctrines, and its aims; its processes, its methods, its propensity to regulate, its obstructiveness, and its self-conceit; its morality, its conscience, and its probity. It worries us to see in it the organ of right and the instrument of justice. We can not arm the state with new rights or fortify its power on one side without re-enforcing it on all sides. The domain of public authority can not be extended over all interests and private contracts without enslaving the individual and subjecting the family to it. No artifice of political science can find means to make the state the master of economical life, the omnipotent arbiter of the mill and the shop, without our societies that live by work being taken wholly into its hand. There is only one way to establish forever the despotism of the state in the world, but there is one, and it is this.

Even if the modern state should become more equitable and more enlightened; if it should become really something else than an irresponsible collectivity exercising power by changing and passionate proxies; if it should put away its sectarian spirit and its tyrannical processes—we should still doubt its competence and its capacity to regulate the mill and the shop. The state is a weighty engine, with slow-running machinery uselessly complicated, which exacts a considerable expenditure of fuel and manual labor for the least work. No other instrument makes a feebler return and wastes so much force. Consequently, the more we extend the action of the state the more we risk impoverishing the country. Instead of hastening the development of national wealth, the state is calculated to hinder it by restraining the free factors of capital and labor. It is always a reproach which its intervention can not escape, and a very grave one in social and economical matters, that the meddling of public authority unnerves private initiative. This of itself would be a cause of uneasiness, for private initiative has always been the main-spring of progress; to break it or paralyze it by enveloping it with laws and regulations which would arrest or restrict its play would be to fetter the progress of industry and of wealth, and to delay the improvement of the condition of the masses. Further than this, in social questions themselves—questions belonging to the workmen—the intervention of the state, with its vexatious processes and its annoying habits, would generally simply end in depressing instead of stimulating private forces and living energies, humanitarian philanthropy and Christian charity. We have already proof of this in public benevolence, which seems, at great expense, to have sterilized the field which private benevolence had fertilized. Beware, lest, instead of inspiring patrons and capitalists, industrial societies and industrial managers, to fulfill their social duty in a larger sense, the arbitrary intervention of the state does not dissuade or discourage them from it! Symptoms of such discouragement are already beginning to appear in France. We, in fact, slander ourselves when we represent that private initiative has been sterile in this sphere. Not so; on the contrary, it is one of the domains in which our end of the century has deserved the most from France and mankind. I want no better evidence of this than the group of social economy, or, as it was justly styled, "of social peace," in our Universal Exposition of 1889, where were represented in fifteen sections: remuneration for labor and participation in benefits; co-operative associations for production; professional syndicates; apprenticeship and patronage societies; mutual aid societies; superannuation and pension funds; accident and life assurance; co-operative consumers' associations; co-operative credit associations; workmen's houses; workmen's circles and people's societies; social hygiene and temperance societies; societies for the protection of children; and national institutions. These fifteen sections of social economy prove by actual specimens that men of means are not insensible to the ills of the working classes, and that our society has not waited for the urging of the state before it occupied itself with questions of interest to working-men. The greater part of the works, foundations, associations, and social enterprises to which awards were made in 1889 were relatively recent, some of them entirely new. They have been tending for several years past to make a rapid advance. Heaven prevent the intervention of the state which is threatened, inflicting a fatal blow on all these creations of private initiative! The state has a heavy hand, not to call it a paw. It often unwittingly crushes what it touches. There is something depressing and stifling in administrative regulation; may it not for a long time yet put the brakes upon a movement from which so much is promised!—*Selected and translated for The Popular Science Monthly from the Revue des Deux Mondes.*

The emigration of the English agricultural population into the towns is attributed by Mr. T. E. Kebbel, among other causes, to the dullness of village life. The old feasts, the fairs, and the games have for the most part disappeared. Thus, while there is vastly more cricket played in England than fifty years ago, it is not played by the same class. In the old day-long matches on the village greens, the elevens were mostly made up of laborers. They are so no longer.

HISTORICAL NOTES ON THE GOLD-CURE.*

By Prof. H. CARRINGTON BOLTON.

AVOIDING all discussion of the merits or demerits of the so-called bichloride-of-gold cure, now so prominent in the public mind, we propose to show that the use of gold as a medicine is not so novel as commonly thought; and by extracts from early writers on chemistry and medicine to indicate the opinions held with respect to alleged "tinctures of gold" at different periods during several centuries.

The precious metal has been employed both externally and internally, in the metallic state, in solution, and by sympathy, for a great variety of the ills that flesh is heir to, for over two thousand years. The train of thought which led the ancients to employ this highly prized material can be well told in the quaint language of the distinguished Dutch physician and chemist, Hermann Boerhaave; writing about 1725, he says: "The alchemists will have this metal contain I know not what radical balm of life capable of restoring health and continuing it to the longest period. What led the early physicians to imagine such wonderful virtue in gold was that they perceived certain qualities therein which they fancied must be conveyed thereby into the body; gold, for instance, is not capable of being destroyed, hence they concluded it must be very proper to preserve animal substances and save them from putrefaction; which is a method of reasoning very much like that of some fanciful physicians who sought for an assuaging remedy in the blood of an ass's ear by reason the ass is a very calm beast!" (Shaw's translation, Boerhaave's Chemistry, London, 1727.)

Something of this sympathetical and mental effect was evidently sought to be attained in the very first instance of the administration of gold recorded in history. "And Moses took the (golden) calf which they had made, and burnt it with fire, and ground it to powder, and strewed it upon the water, and made the children of Israel drink of it." (Exodus, xxxii, 20.)

Pliny, in his marvelous compilation, "Natural History," written about 70 A. D., has a paragraph on the "medicinable virtues of gold" which in "divers waies is effectual in the cure of many diseases. For first of all sovereign it is for green wounds, if it be outwardly applied." Pliny describes a form of liniment of gold "torrefied with salt and schistis" which "healeth the foule tettar that appeareth in the face," fistulas, etc. And he alludes to a preparation of gold in honey which "doth gently loose the belly if

* Read, in part, to the New York Academy of Sciences, June 6, 1892.

the navel be anointed therewith." And in conclusion Pliny quotes Marcus Varro, who "saith that gold wil cause warts to fal off." (Holland's translation, London, 1634.) Varro was a friend of Cicero, which carries back this belief in the efficacy of gold to the first century before Christ.

The Arabian physicians, who for hundreds of years possessed almost exclusive knowledge of chemistry, often record the virtues of gold as a remedial agent in disease. Geber, who lived in the eighth century, wrote: "Gold is a medicine rejoycing and conserving the Body in Youth." (Russell's translation, London, 1678, p. 76.) Avicenna is said to have also written in its praise; also Arnald de Villanova (1235–1312).

The preparation of gold in a potable, innocuous form occupied the attention of the alchemists during several centuries; they commonly called it *aurum potabile*, and ascribed to it not only remedial virtues but the power of prolonging life. The quotation from Geber shows that he shared this opinion.

To this elixir of life they gave many fanciful names: Elias Ashmole, in his Theatrum Chemicum Britannicum, says Saint Dunstan calls it the "food of angels," and others the "heavenly viaticum." Ashmole himself adds: "It is undoubtedly the true Alchochodon or giver of years, for by it man's body is preserved from corruption, being thereby enabled to live a long time without food; nay, 'tis made a question whether any man can die that uses it." (Written in 1652.)

The alchemists argued that this golden elixir is not to be made of vulgar gold, but only from philosophical gold prepared by hermetic art. Recipes for manufacturing this panacea abound in alchemical works, they are mostly very tedious, requiring endless repetitions and much faith on the part of the operator. One of the simplest methods of preparing *aurum potabile* is given by Samuel Bolton in his curious little 16mo, "Medicina magica tamen physica," published at London in 1650: "Put foliated gold into a vessel well sealed with Hermes' seal; put it into our fire till it be calcined to ashes; then sublime it into *flores*, having his *caput mortuum*, or black *terra damnata* in the bottom. Then let that which is sublimed be with the same degree of fire united to the same *caput mortuum* that it may be revived by it, as that all may be reduced into an Oyle which is called *Oleum Solis*. The dose hereof is two or three grains."

This description leaves much to the imagination, and in this respect differs little from others that we might quote. For the benefit of non-chemists we may add that few of the recipes yield a product containing gold, the metal often remaining in the part thrown away.

Roger Bacon, the Franciscan friar of the thirteenth century, to whom so many wonderful discoveries and inventions have been ascribed, had deep faith in the virtues of potable gold. Bacon, in a communication to Pope Nicolas IV, informs his Holiness of an old man who found some yellow liquor in a golden flask, when plowing one day in Sicily. Supposing it to be dew, he drank it off, and was immediately transformed into a hale, robust, and highly accomplished youth. Having abandoned his day-laboring he was admitted to the service of the King of Sicily, and served the court eighty years.

The belief in a life-prolonging elixir, sometimes claimed of the tincture of gold and sometimes of secret preparations, prevailed for centuries. Even so great a philosopher as Descartes believed he had attained the art of living a few hundred years; this belief was shared by some of his friends, and when he died before reaching sixty years they were convinced that he had been poisoned.

The alchemist Raymond Lully a contemporary of Friar Bacon, also experienced the restorative effect of this fountain of youth, if we can credit the statement in the curious verses of Sir George Ripley, composed in 1471:

"An Oyle is drawne owte in colour of Gold,
Or lyke thereto out of our fire Red Lead,
Whych Raymond sayd when he was old,
Much more than Gold wold stand hym in stede.
For when he was for age nygh dede,
He made thereof *Aurum Potabile*
Whych hym revyvyd as men myght see."
(Compound of Alchymie.)

Oswald Croll, a German physician of the sixteenth century, wrote in 1609 in praise of gold as a medicine. I quote the English translation of his Basilica chymica, published at London in 1670:

"It is the principle part of a Physician that would Cure the Sick, first to comfort the Heart, and afterwards assault the Disease. Those to whom the harmonious Analogy of Superiours and Inferiours hath been known, and who from Suffrages of Astrologers have learned that to the two greatest Lights of Heaven, the two principle parts of Man, viz: the Heart and Brain, in things of Nature latently rests in *Gold*. . . . For Nature hath endowed Gold with no contemptible virtues, which who so knows how to draw out, and by ingenious Artifice is able rightly to use, he will find Gold, which seemed dead and barren, so lively and pregnant that it germinates and of itself progenerates new Gold. . . . Whence the true Philosophers have exquisitely prepared a wonderful and greatly to be desired Medicine with which the impurities of imperfect metals are removed and all vices of affects in uncurable Diseases of Humane Bodies perfectly exterminated."

Croll then says he has tried almost one hundred different preparations of *aurum potabile*, and condemns most of them to recommend his own, fulminating gold, called by him "Calx of Sol." His process embraces nauseous ingredients, and the product is, as usual, free from gold.

Paracelsus, the physician who did so much to improve materia medica by introducing chemical medicines, does not neglect gold. Thurneisser, his disciple (both as respects his teachings and his charlatanism), made his royal dupes pay enormous sums for the "tincture of gold" which entered into his extraordinary prescriptions. To the use of royal touch pieces (gold coins) in the reigns of Charles II, James II, and Queen Anne, mere allusion should be made. Christopher Glaser (1663) gives among other preparations a "diaphoretic powder of gold" and prescribes it for continuous or intermittent fevers, the dose being four to twelve grains in wine, or in a spoonful of bouillon. (Traité de la chymie, Paris, 1663.)

Antoine Lecoq (or Gallus), a physician of Paris (1540), seems to have been the first to recommend gold for syphilis. He and his follower Fallopius (of Modena, 1565) described tedious processes for making preparations of gold. These processes were carefully repeated, about the beginning of this century, by Chevallier, a French pharmacist, who declares the products contain no gold at all.

Lamotte's "gold-drops," celebrated throughout Europe for over half a century (1725 to 1780), consisted of a solution of ferric chloride in alcohol; this possessed a yellow color, and was universally regarded as a tincture of gold, until the secret was bought and made public by the Russian Government. (Kopp's Geschichte.)

Frederic Hoffman, a famous German physician (1733), recommends gold for rheumatic fever.

Johann Rudolph Glauber, the German physician whose name is indelibly attached to "Glauber's salts," thought to improve the latter by adding gold. "In all diseases and infirmities, of what name soever, the Spirit or Oil of Salt in which gold is rightly dissolved (or the *Aurum Potabile* with it), giveth present help, and in all dejections of the vital spirit . . . it giveth such relief that life and vigor may be somewhat farther protracted if two, three or four drops be administered as occasion shall serve in good Aqua vitæ or Cordiall Water. In like manner if three drops be administered once a week in generous wine or aqua vitæ, or other fit vehicle, it renovateth a man, makes him youthful, changeth gray hairs, produceth new nails and skin, preserveth from various and divers symptoms of diseases, and preserveth the body in such a state even to the prefixed hour of the Divine appointment."

This is quoted by Glauber from Conrad Khunrath in his Medulla destillatoria, and he adds: "I some time since administered this Oil of gold for eight or ten days successively to an Infant for the freeing his body from mercury." (Glauber's Works, Packe's translation, London, 1689.)

Robert Boyle, in his Usefulness of Natural Experimental Philosophy (1663), expresses doubts as to the "strange excellency" of *aurum potabile,* remarking that "learned physicians and chymists have pronounced the preparation of potable gold as itself unfeasible." And he adds: "I should much doubt whether such a potable gold would have the prodigious virtues its encomiasts ascribe to it and expect from it; for I finde not that those I have yet met with deliver these strange things upon particular experiments duly made, but partly upon the authority of chymicall books, many of which were never written by those whose names they bear." He then proceeds to blame physicians for using expensive medicines and says: "T'were a good work to substitute cheap ones for the poorer sort of patients."

The change of opinion as respects the therapeutic value of gold, foreshadowed in the quotation from the astute Boyle, is well shown by comparing the passages on the subject in two different editions of Lémery's Cours de Chymie, one published in 1680 and one in 1730. In the earlier edition of Lémery's very successful work we read: "Gold is a good remedy for those that have taken too much mercury, for these two metals do easily unite together, and by this union or amalgamation the mercury fixes and its motion is interrupted." (Page 25.) "*Aurum fulminans* causes sweat and drives out ill humors by transpiration. It may be given in the small pox two to six grains in a lozenge or electuary. It stops vomiting and is also good to moderate the active motion of mercury." (Harris's translation, London, 1680, page 9.)

And in the later edition, the eleventh of the series, Lémery or his editor makes a very different statement:

"Potable gold, so much praised by the alchemists, and sold so dear by them, is commonly only a vegetable or mineral tincture of a color resembling gold, and as they make this tincture with a spirituous menstruum, it sometimes excites perspiration. This effect they ascribe to the gold, although the metal has rarely anything to do with it." (1730.)

In the works of Caspar Neumann a passage occurs that expresses so clearly the present views of many that it is hard to realize it was written nearly one hundred and fifty years ago. Neumann writes:

"Gold has been imagined to be possessed of extraordinary medicinal virtues, and many preparations, dignified with the name of this precious metal, have been imposed upon the public;

but the virtues ascribed to gold have apparently no other foundation than credulity and superstition, and most of the golden medicines have no gold in them. Even when gold has been employed in the preparation there is seldom any of it retained in the product.

"We may say with Ludovici, 'It is better to make gold out of medicines than medicines out of gold.'" (Lewis's translation, London, 1759, page 38.)

FAMILIES AND DWELLINGS.

VII.—LESSONS FROM THE CENSUS.

By CARROLL D. WRIGHT, A. M.,
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THE statistics of families and dwellings, as shown by a census, offer opportunities for the study of social conditions in some very important directions. The ratio of dwellings to families, the number of persons to a dwelling, and the average size of families are all facts of the highest importance in considering the condition of the people. Such statistics also answer the question whether families are holding their own as to size, and allied with modern facts relative to the number of children born and living they enable one to determine the composition of the population and whether its various elements are being preserved with reasonable integrity.

The following short table shows the total number of families and persons to a family, by geographical divisions, in the United States, June 1, 1890:

Total Families and Persons to a Family, by Geographical Divisions.

Geographical Divisions.	Number of Families.					Persons to a Family.				
	1890.	1880.	1870.	1860.	1850.	1890.	1880.	1870.	1860.	1850.
North Atlantic	3,712,242	3,023,741	2,497,494	2,048,315	1,582,978	4·69	4·80	4·92	5·17	5·45
South Atlantic	1,687,767	1,463,361	1,132,621	652,396	537,857	5·25	5·19	5·17	5·40	5·61
North Central	4,598,605	3,389,017	2,480,311	1,683,190	934,873	4·86	5·12	5·23	5·34	5·69
South Central	2,071,120	1,697,550	1,242,411	684,024	499,767	5·30	5·25	5·18	5·51	5·70
Western	620,418	372,247	226,526	143,009	42,765	4·88	4·75	4·37	4·33	4·18
The United States	12,690,152	9,945,916	7,579,363	5,210,934	3,598,240	4·94	5·04	5·09	5·28	5·55

The number of families increased, from 1880 to 1890, 27·59 per cent; from 1870 to 1880, 21·22 per cent; from 1860 to 1870, 45·45 per cent; and from 1850 to 1860, 44·82 per cent.

The question is often asked, when the total number of families and the size of families under censuses are considered, what the word "family" really means. For census purposes the word "family" comprehends not only the real, normal family, as it is commonly understood—that is, consisting of the husband, wife, children, and immediate dependents like relatives and servants—but it comprehends all persons living alone where they maintain their own establishments, and all larger aggregations of people subject to one common supervision, such as the inmates of hotels, hospitals, prisons, asylums, etc. So in nearly all Federal and State censuses in this country and all censuses abroad the family has comprehended hotels, boarding-houses, lodging-houses, penal and reformatory institutions, and every aggregation of individuals living under one roof, or has related in some way, either arbitrarily or otherwise, to one head. The inmates of a great hotel, or a great college, or a prison constitute, for census purposes, a family. It would seem at first thought that this artificial extension of the composition of the family would have a disturbing influence upon the average size of the family, but a careful analysis of results indicates that such influence is very slight. In the census of Massachusetts for 1885, the census family in its average size consisted of 4·58 persons. The Massachusetts State census offered facilities for ascertaining just the effect of considering institutions and other bodies as families upon the normal family. Eliminating all families coming under the artificial designation, it was found that the average size of the actual normal family of Massachusetts in 1885 was 4·45. The influence, therefore, arising from the inclusion of the artificial or arbitrary family, so far as that State taken as a whole was concerned, was but ·13 per cent—that is, the difference between 4·58, the average for all families of all sizes, and 4·45, the average of the normal family alone. Practically, it makes but little difference, then, so far as great bodies of people are concerned—as, for instance, the population of a State—whether the families are considered on the basis of the actual normal family or on the ordinary census basis, which includes all aggregations living under one roof or having certain relations to one head. It would not do, however, to consider this as a rule in small aggregations of people. As an illustration, Danvers, in the State of Massachusetts, contains a large asylum for the insane. The number of families in 1885, including the asylum, was 1,474, representing a population of 7,061. The average size of families on this census basis for the town of Danvers in the year named was 4·79; but, eliminating the asylum as a family, the average size of the families was 4·17, too large a variation for accurate calculations. Again, in the town of Concord, in the State named, containing the reformatory prison, the average size of the family, including the reformatory, was 5.15; excluding it, it was 4·62. Taking a college town, Wellesley, the average size of the normal family was 5·10; but, including Wellesley College, it was 6·15, or an increase of more than one person. The rule, therefore, that the average size of the family is not materially affected by including the artificial or arbitrary family does not well apply to towns and cities in which large institutions are located. For the United States the statements given by the census, which includes all arbitrary families, may fairly be taken as representing the average family.

The decrease in the size of families is a subject which causes some alarm. Taking the United States as a whole, it is found by the census figures that in 1850 the average family consisted of 5·55 persons. There has been a gradual decrease, it being in 1860 5·28, in 1870 5·09, in 1880 5·04, and in 1890 4·94. Looking at the different geographical divisions, it is found that this rule holds true except in the Western division, where the average size of the family has risen from 4·18 in 1850 to 4·88 in 1890, the increase having been steady through the intermediate decades. This result would have been expected, of course, on account of the settlement of the West in the last few years, the population having increased rapidly and being more and more brought to the family basis instead of that of single individuals or young families settling in Western Territories. The small average size of the family in Oklahoma, now a Territory just opened for settlement, shows the influence of new settlements upon the size of the family. In Oklahoma the size of the family will increase until population becomes fairly dense, when it will follow the rule of older communities and decrease. When population becomes more or less urban in character the maximum is reached, and after that a constantly receding average will probably be shown at each succeeding census. A study of one hundred of the principal cities of the country having a population of 25,000 or more, and on the basis of 1880 and 1890, shows with but few exceptions a decrease in the average size of the family. The exceptions are chiefly in the South and West, as might be expected, and as is found regarding those two sections generally. In New York city the average size of the family has decreased from 4·96 in 1880 to 4·84 in 1890, while in Chicago the decrease has been from 5·19 to 4·99 during the same period.

It would be very gratifying if the Federal census statements as to size of families and other social features of population could be carefully verified by independent enumerations. This possibility exists in some cases where States take an independent census. I will call attention to one only, and that the State of Massachusetts, with whose statistics I am more or less familiar. The United States census just taken gives the average size of family in Massachusetts in 1870 as 4·77. The State census of 1875 gives the average size as 4·60. In 1880 the Federal census shows an average size of family of 4·70, and in 1890 of 4·67. The State census for 1885 gives the average size of family as 4·58. In each case the size of family as shown by the Federal census is slightly larger than that shown by the State census. It would be quite impossible to quarrel with the Federal census so far as this single comparison is concerned.

In the eleventh census a question entirely novel in Federal censuses was asked on the population schedule. This question was as follows: "Mother of how many children, and number of these children living?" This inquiry was made concerning all women who are or have been married, including those widowed or divorced. The results of this inquiry will be of the very greatest importance. It was asked in the State census of Massachusetts for 1885. The question relates to the fecundity of women, and if the tabulations are proper will give this for different nationalities. The question involves the comparative growth of the native and foreign-born population, and is a subject of very vital importance. In the Massachusetts census for 1875 a beginning was made in the direction of securing information on this point, but to a limited extent only. In that census an inquiry was made relating simply to the number of children born to each mother; but in 1885, in the State referred to, the inquiry was extended to the form just quoted. The statistics presented in the State census for 1885 confirmed the information secured in 1875 as to the relative fecundity of women, and also supplied data in the nature of vital statistics bearing directly upon the question often raised as to whether it is better to have small families, well reared, as opposed to large families of children not always brought up under the best and most healthful conditions. The figures gathered in the State of Massachusetts showed that foreign-born mothers were more prolific than native-born mothers, while at the second inquiry it was shown that the number of children of foreign-born mothers decreased relative to the time they had lived in this country; and the general results, considered on broad grounds, indicated that the mothers having purely native parentage have relatively a slightly greater proportion of their children living than the mothers having purely foreign parentage.

The effect of dense population upon the decreasing size of the family is suggested by these crude results; but, after the Federal and State censuses shall have repeated the inquiry quoted, we may be able to determine with reasonable accuracy the exact facts relative to the decrease of families. The first results under the Federal census will be chiefly valuable because from them comparisons in future censuses can be made, and from them also can be shown whether more children are brought to mature age when members of small families than when members of large families. This is an exceedingly vital question, and much light will be thrown upon it under future statistical investigations.

In discussing the number of families and the composition thereof, it is interesting always to learn the relation of persons to dwellings. The following table gives the total number of dwellings and persons to a dwelling, by geographical divisions, under the census of 1890:

Total Dwellings and Persons to a Dwelling, by Geographical Divisions.

Geographical Divisions.	Number of Dwellings.					Persons to a Dwelling.				
	1890.	1880.	1870.	1860.	1850.	1890.	1880.	1870.	1860.	1850.
North Atlantic.....	2,962,345	2,430,182	2,103,500	1,808,435	1,390,005	5·87	5·97	5·85	5·86	6·21
South Atlantic.....	1,626,372	1,383,493	1,102,778	656,074	528,596	5·45	5·49	5·31	5·37	5·71
North Central......	4,287,486	3,172,734	2,405,626	1,688,446	911,565	5·22	5·47	5·40	5·32	5·83
South Central......	2,007,279	1,623,664	1,197,569	668,387	490,280	5·47	5·49	5·37	5·64	5·81
Western...........	599,836	345,739	233,360	148,350	41,891	5·05	5·11	4·24	4·[illegible]	4·27
The United States	11,483,318	8,955,812	7,042,833	4,969,692	3,362,337	5·45	5·60	5·47	5·53	5·94

An examination of the foregoing table proves that the number of persons to a dwelling is constantly decreasing, although slightly, thus indicating increased comfort on the part of the population as a whole. In 1850 there were 5·94 persons to each dwelling in the country, while in 1890 the average was 5·45. In the West, however, this statement is reversed, for in 1850 the number of persons to a dwelling was 4·27, and in 1890 it had increased to 5·05. This, as in the case of the increased size of family, shows the effects of the new settlements.

A dwelling, for census purposes, means any building or place of abode in which any person was living at the time the census was taken, whether the abode was a room above a warehouse or factory, a loft above a stable, a wigwam on the outskirts of a settlement, a hotel, a boarding or lodging house, a large tenement-house, or the dwelling-house ordinarily considered as such. On this basis the number of dwellings in 1890 had increased 28·22 per cent over the number in 1880. In 1890 there were 11,483,318 dwellings and 12,690,152 families, there thus being 10·51 per cent more families than dwellings, while in 1880 the excess was 11·06 per cent, and in 1850 it was 7·02 per cent.

It should be remembered, in making any comparison between dwellings and persons from 1850 to 1890, that in 1860 and 1870 the total number of dwellings included both occupied and unoccupied dwellings, while in 1850, 1880, and 1890 the total number of occupied dwellings only was reported. Again, in 1850 and 1860 the number of dwellings stated was for the free population only, the dwellings of the slave population in those censuses not being returned. Any figures, therefore, for 1850 to 1870, inclusive, do not afford a very fair basis of comparison. The table just given should be used in the light of these remarks.

The excess of families over dwellings in 1890, 1880, and 1850, both as regards number and per cent, is shown in the following brief table:

Excess of Families over Dwellings.

Geographical Divisions.	1890.		1880.		1850.	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
North Atlantic	749,897	25·31	593,559	24·42	192,973	13·88
South Atlantic	61,395	3·77	79,868	5·77	9,261	1·75
North Central	311,119	7·26	216,283	6·82	23,308	2·56
South Central	63,841	3·18	73,886	4·55	9,487	1·94
Western	20,582	3·43	26,508	7·67	874	2·09
The United States	1,206,834	10·51	990,104	11·06	235,903	7·02

The statistics of dwellings and families already published show the classification by the number of persons and dwellings for the different States and by the United States as a whole. The following brief summary, however, by geographical divisions, is all that space will permit. This table shows the total number of persons to a dwelling, from 1 person to 11 and over:

Persons to a Dwelling, by Geographical Divisions.

Geographical Divisions.	1 person.	2 persons.	3 persons.	4 persons.	5 persons.	6 persons.
North Atlantic	71,997	342,778	458,510	477,258	432,942	337,780
South Atlantic	51,364	166,833	223,395	238,170	236,164	200,911
North Central	130,596	481,266	669,220	723,592	667,602	526,535
South Central	55,661	203,005	273,430	294,503	294,368	249,862
Western	60,449	79,854	87,343	88,569	81,449	60,865
The United States	370,067	1,276,736	1,711,898	1,822,092	1,712,525	1,375,953

Geographical Divisions.	7 persons.	8 persons.	9 persons.	10 persons.	11 persons and over.
North Atlantic	249,985	175,762	118,176	87,393	209,764
South Atlantic	166,054	127,770	89,290	70,393	56,028
North Central	386,706	266,911	169,576	115,906	146,576
South Central	208,350	160,019	112,402	90,315	65,364
Western	45,194	32,106	21,625	21,142	21,240
The United States	1,056,289	762,568	511,069	385,149	498,972

The facts in the foregoing table, reduced to percentages and to a classification somewhat briefer than the foregoing summaries, give the following results:

Geographical Divisions.	Persons to a Dwelling.							
	1 person.		2 to 6 persons.		7 to 10 persons.		11 persons and over.	
	Per cent of dwellings.	Per cent of population.	Per cent of dwellings.	Per cent of population.	Per cent of dwellings.	Per cent of population.	Per cent of dwellings.	Per cent of population.
North Atlantic	2·43	0·41	69·18	46·91	21·31	29·27	7·08	23·41
South Atlantic	3·16	0·58	65·51	49·03	27·89	41·68	3·44	8·71
North Central	3·05	0·58	71·63	55·31	21·90	33·66	3·42	10·45
South Central	2·77	0·51	65·52	48·99	28·45	42·40	3·26	8·10
Western	10·08	2·00	66·37	51·14	20·01	32·34	3·54	14·52
The United States	3·22	0·59	68·79	50·78	23·64	35·04	4·35	13·59

From this table it is understood that the number of dwellings having 1 person only represents 3·22 per cent of the whole number of dwellings in the United States, while the population of such dwellings is but ·59 per cent of the total population. Dwellings containing from 2 to 6 persons represent over two thirds of all the dwellings, and about one half of the whole population. About 4·33 per cent of the dwellings contain more than 10 persons, and represent 13·59 per cent of the total population. Examining the results in this direction for twenty-eight cities, or those having a population of 100,000 and over, the Census Office presents the following tabular statement:

Cities.	Persons to a dwelling.							
	1 person.		2 to 6 persons.		7 to 10 persons.		11 persons and over.	
	Per cent of dwellings.	Per cent of population.	Per cent of dwellings.	Per cent of population.	Per cent of dwellings.	Per cent of population.	Per cent of dwellings.	Per cent of population.
New York, N. Y.	1·29	0·07	26·45	6·27	22·44	10·16	49·82	83·50
Chicago, Ill.	1·00	0·12	45·54	22·85	28·92	27·85	24·54	49·18
Philadelphia, Pa.	1·15	0·20	69·94	51·75	24·52	35·26	4·39	12·79
Brooklyn, N. Y.	0·97	0·10	39·30	17·83	30·08	25·42	29·65	56·65
St. Louis, Mo.	2·46	0·33	49·77	28·54	81·31	34·87	16·46	36·26
Boston, Mass.	1·19	0·14	44·18	22·35	30·40	29·71	24·23	47·80
Baltimore, Md.	1·09	0·18	62·22	44·31	30·80	41·37	5·89	14·14
San Francisco, Cal.	3·65	0·58	64·43	41·18	24·88	32·07	7·04	26·17
Cincinnati, Ohio.	1·32	0·15	45·75	22·23	28·03	26·10	24·90	51·52
Cleveland, Ohio	1·29	0·21	65·38	46·02	26·80	36·35	6·53	17·42
Buffalo, N. Y.	1·23	0·18	57·31	35·42	28·76	34·38	12·70	30·02
New Orleans, La.	3·16	0·56	65·81	47·08	25·81	37·42	5·22	14·94
Pittsburg, Pa.	1·30	0·20	59·41	40·02	30·83	39·72	8·46	20·06
Washington, D. C.	1·96	0·33	64·13	45·38	28·36	38·74	5·55	15·55
Detroit, Mich.	1·31	0·23	69·44	51·44	24·19	34·86	5·06	13·47
Milwaukee, Wis.	1·56	0·25	60·54	41·12	29·16	38·04	8·74	20·59
Newark, N. J.	0·94	0·12	48·67	27·29	30·90	32·58	19·49	40·01
Minneapolis, Minn.	4·07	0·63	57·37	37·55	28·00	34·96	10·56	26·86
Jersey City, N. J.	1·02	0·12	47·50	23·63	28·71	26·84	22·77	49·41
Louisville, Ky.	1·80	0·28	58·64	38·44	29·58	37·54	9·98	23·74
Omaha, Neb.	1·29	0·19	59·16	36·27	31·32	37·95	8·23	25·59
Rochester, N. Y.	1·52	0·27	69·66	51·27	24·15	34·86	4·67	13·60
St. Paul, Minn.	3·69	0·58	59·20	39·62	27·94	35·73	9·17	24·07
Kansas City, Mo.	3·43	0·60	66·59	46·79	23·89	34·01	6·09	18·60
Providence, R. I.	1·71	0·23	48·32	27·43	31·38	34·58	18·59	37·76
Denver, Col.	2·87	0·48	68·31	46·28	22·74	31·53	6·08	21·71
Indianapolis, Ind.	2·13	0·43	77·54	61·16	17·71	28·34	2·62	10·07
Allegheny, Pa.	1·00	0·16	59·23	40·12	31·36	40·15	8·41	19·57

From this table we find that there were in New York city at the time of the last Federal census a total of 81,828 occupied dwellings. More than 50 per cent of these contain from 1 to 10 persons, and a little less than 50 per cent contain more than 10 persons. The population represented by dwellings in New York city having 10 persons or less is 250,002, or 16·50 per cent of the whole population, while the population represented by dwellings having more than 10 occupants is 1,265,299, or 83·50 per cent of the entire population.

The population of Chicago is about evenly divided between the two classes of dwellings, 50·82 per cent living in dwellings having from 1 to 10 occupants, and 49·18 per cent living in dwellings containing more than 10 persons each on the average.

In Philadelphia a very different condition of affairs is seen.

Out of a total of 187,052 dwellings, which is more than twice the number of dwellings in New York city and about 50 per cent more than in Chicago, 178,839, or 95·61 per cent, of the dwellings contain 10 persons or less, and only 8,213 dwellings, or 4·39 per cent of the whole, contain more than 10 persons. Relative to population, 913,076 out of a total of 1,046,964 people in Philadelphia live in dwellings containing 10 persons or less, and this is 87·21 per cent of the total population, while only 12·79 per cent of the total population, or, in round numbers, 133,888, live in dwellings having more than 10 occupants.

This is so important a subject, and one which the public desires so much to study, that I repeat one of the tables given in the recent census bulletin on dwellings and families. This table is for the twelve cities stated in the preceding one, and it shows the figures concerning persons in dwellings having more than 10 occupants, the per cent of dwellings having from 1 to 10 persons, from 11 to 15 persons, from 16 to 20 persons, and 21 persons and over, each, together with the population by number and per cent contained in such dwellings:

Cities.	Total dwellings.	Dwellings with				Total population.	Population of dwellings with			
		1 to 10 persons.	11 to 15 persons.	16 to 20 persons.	21 persons and over.		1 to 10 persons.	11 to 15 persons.	16 to 20 persons.	21 persons and over.
NUMBER.										
New York....	81,828	41,059	10,384	6,789	23,596	1,515,301	250,002	133,018	121,495	1,010,786
Chicago......	127,871	96,493	17,760	7,509	6,1[illegible]9	1,099,850	558,927	225,123	132,925	182,875
Philadelphia..	187,052	178,839	6,403	1,135	675	1,046,964	913,076	78,228	20,000	35,660
Brooklyn.....	82,282	57,882	12,055	5,465	6,880	806,343	349,532	152,631	96,930	207,250
St. Louis.....	60,937	50,907	6,668	1,987	1,375	451,770	287,983	82,976	34,999	45,812
Boston.......	52,669	39,908	8,082	2,818	1,861	448,477	234,123	102,332	49,540	62,482
Baltimore....	72,112	67,867	3,603	384	258	434,439	373,031	43,585	6,727	11,096
Cincinnati....	33,487	25,149	4,189	1,976	2,173	296,908	143,947	52,832	35,043	65,086
Buffalo.......	37,290	32,556	3,237	894	603	255,664	178,919	40,339	15,729	20,677
Newark......	23,296	18,755	2,962	959	620	181,830	109,085	37,248	16,857	18,640
Jersey City...	18,562	14,336	2,011	944	1,271	163,003	82,467	25,428	16,757	38,351
Providence...	17,639	14,360	2,267	672	340	132,146	82,255	28,243	11,756	9,892
PER CENT.										
New York....	....	50·18	12·69	8·30	28·83	....	16·50	8·78	8·02	66·70
Chicago......	....	75·46	13·89	5·87	4·78	....	50·82	20·47	12·08	16·63
Philadelphia..	....	95·61	3·42	0·61	0.36	....	87·21	7·47	1·91	3·41
Brooklyn.....	....	70·35	14·65	6·64	8·36	....	43·35	18·93	12·02	25·70
St. Louis.....	....	83·54	10·94	3·26	2·26	....	63·74	18·37	7·75	10·14
Boston.......	....	75·77	15·35	5·35	3·53	....	52·20	22·82	11·05	13·93
Baltimore....	....	94·11	5·00	0·53	0·36	....	85·87	10·03	1·55	2·55
Cincinnati....	....	75·10	12·51	5·90	6·49	....	48·48	17.80	11·80	21·92
Buffalo.......	....	87·30	8·68	2·40	1·62	....	69·98	15·78	6·15	8·09
Newark......	....	80·51	12·71	4·12	2·66	....	59·99	20·49	9·27	10·25
Jersey City...	....	77·23	10·83	5·09	6·85	....	50·59	15·60	10·28	23·53
Providence...	....	81·41	12·85	3·81	1·93	....	62·24	21·37	8·90	7·49

"From this table it is seen that in New York city 23,596 dwellings, or 28.83 per cent of all the dwellings, have more than 20 persons to each dwelling, and contain in the aggregate 1,010,786 persons, or 66·70 per cent of its total population. Of this number of dwellings it has been found, by a special tally for New York city, that 8,313 contain from 21 to 30 persons, 9,350 from 31 to 50 persons, 5,460 from 51 to 100 persons, and 473 over 100 persons. In Brooklyn 25·70 per cent, in Jersey City 23·53 per cent, and in Cincinnati 21·92 per cent of their total population live in dwellings containing more than 20 persons. The per cent of population in Chicago living in dwellings with more than 20 persons to a dwelling is 16·63 per cent, in St. Louis 10·14 per cent, in Boston 13·93 per cent, in Buffalo 8·09 per cent, in Newark 10·25 per cent, and in Providence 7·49 per cent. In Philadelphia only 3·41 per cent and in Baltimore but 2·55 per cent of the population are contained in dwellings with more than 20 persons."

VERACITY.*

By HERBERT SPENCER.

COMPLETE truthfulness is one of the rarest of virtues. Even those who regard themselves as absolutely truthful are daily guilty of over-statements and under-statements. Exaggeration is almost universal. The perpetual use of the word "very," where the occasion does not call for it, shows how widely diffused and confirmed is the habit of misrepresentation. And this habit sometimes goes along with the loudest denunciations of falsehood. After much vehement talk about "the veracities," will come utterly unveracious accounts of things and people—accounts made unveracious by the use of emphatic words where ordinary words alone are warranted: pictures of which the outlines are correct but the lights and shades and colors are doubly and trebly as strong as they should be.

Here, among the countless deviations of statement from fact, we are concerned only with those in which form is wrong as well as color—those in which the statement is not merely a perversion of the fact but, practically, an inversion of it. Chiefly, too, we have to deal with cases in which personal interests of one or other kind are the prompters to falsehood:—now the desire to inflict injury, as by false witness; now the desire to gain a material advantage; now the desire to escape a punishment or other threatened evil; now the desire to get favor by saying that which pleases. For in mankind at large, the love of truth for truth's sake, irrespective of ends, is but little exemplified.

Here let us contemplate some of the illustrations of veracity and unveracity—chiefly unveracity—furnished by various human races.

The members of wild tribes in different parts of the world, who, as hunters or as nomads, are more or less hostile to their neigh-

* From The Principles of Ethics, vol. i, by Herbert Spencer. New York: D. Appleton & Co., 1892.

bors, are nearly always reprobated by travelers for their untruthfulness; as are also the members of larger societies consolidated by conquest under despotic rulers.

Says Burton of the Dakotas—"The Indian, like other savages, never tells the truth." Of the Mishmis, Griffith writes—"They have so little regard for truth, that one can not rely much on what they say." And a general remark, *à propos* of the Kirghiz, is to the same effect. "Truth, throughout Central Asia, is subservient to the powerful, and the ruler who governs leniently commands but little respect."

Of the settled societies, the first to be named is the Fijian. Williams tells us that—

> "Among the Fijians the propensity to lie is so strong, that they seem to have no wish to deny its existence. . . . Adroitness in lying is attained by the constant use made of it to conceal the schemes and plots of the Chiefs, to whom a ready and clever liar is a valuable acquisition. . . . 'A Fijian truth' has been regarded as a synonym for a lie."

Of kindred nature, under kindred conditions, is the trait displayed by the people of Uganda.

> "In common with all savage tribes, truth is held in very low estimation, and it is never considered wrong to tell lies; indeed, a successful liar is considered a smart, clever fellow, and rather admired."

So, too, was it among the ancient semi-civilized peoples of Central America. De Laet says of certain of them, living under a despotic and bloody regime—"they are liars, like most of the Indians." And concerning the modern Indians, who may be supposed to have preserved more or less the character of their progenitors, Dunlop writes:—

> "I never have found any native of Central America, who would admit that there could be any vice in lying; and when one has succeeded in cheating another, however gross and infamous the fraud may be, the natives will only remark, '*Que hombre vivo*' (What a clever fellow)."

A like fact is given by Mr. Foreman in his work on the Philippine Islands. He says the natives do not "appear to regard lying as a sin, but rather as a legitimate, though cunning, convenience."

The literatures of ancient semi-civilized peoples yield evidence of stages during which truth was little esteemed, or rather, during which lying was tacitly or openly applauded. As we saw in a recent chapter (§ 127) deception, joined with atrocity, was occasionally inculcated in the early Indian literature as a means to personal advancement. We have proof in the Bible that, apart from the lying which constituted false witness, and was to the injury of a neighbor, there was among the Hebrews but little reprobation of lying. Indeed it would be remarkable were it otherwise, considering that Jahveh set the example; as when, to ruin Ahab, he commissioned "a lying spirit" (1 Kings, xxii, 22) to deceive his prophets; or as when, according to Ezekiel, xiv, 9, he threatened to use deception as a means of vengeance.

"If the prophet be deceived when he hath spoken a thing, I the Lord have deceived that prophet, and I will stretch out my hand upon him, and will destroy him from the midst of my people Israel."

Evidently from a race-character which evolved such a conception of a deity's principles, there naturally came no great regard for veracity. This we see in sundry cases; as when Isaac said Rebecca was not his wife but his sister, and nevertheless received the same year a bountiful harvest: "the Lord blessed him" (Genesis, xxvi, 12); or as when Rebecca induced Jacob to tell a lie to his father and defraud Esau—a lie not condemned but shortly followed by a divine promise of prosperity; or as when Jeremiah tells a falsehood at the king's suggestion. Nor do we find the standard much changed in the days of Christ and after: instance the case of Paul, who, apparently rather piquing himself on his "craft and guile," elsewhere defends his acts by contending that "the truth of God hath more abounded through my lie unto his glory." (Romans, iii, 7.)

Much regard for veracity was hardly to be expected among the Greeks. In the *Iliad* the gods are represented not only as deceiving men but as deceiving one another. The chiefs "do not hesitate at all manner of lying." Pallas Athene is described as loving Ulysses because he is so deceitful; and, in the words of Mahaffy, the Homeric society is full of guile and falsehood."* Nor was it widely otherwise in later days. The trait alleged of the Cretans—"always liars"—though it may have been more marked in them than in Greeks at large, did not constitute an essential difference. Mahaffy describes Greek conduct in the Attic age as characterized by "treachery" and "selfish knavery,"

* Marvelous are the effects of educational bias. Familiarity with the doings of these people, guilty of so many "atrocities," characterized by such "revolting cruelty of manners," as Grote says, who were liars through all grades from their gods down to their slaves, and whose religion was made up of gross and brutal superstitions, distinguishes one of our leading statesmen; and, joined to familiarity with the doings of other Greeks, is thought by him to furnish the best possible preparation for life of the highest kind. In a speech at Eton, reported in *The Times*, of 16 March, 1891, Mr. Gladstone said—"If the purpose of education is to fit the human mind for the efficient performance of the greatest functions, the ancient culture, and, above all, Greek culture, is by far the best, the most lasting, and the most elastic instrument that can possibly be applied to it." Other questions aside, one might ask with puzzled curiosity which of Mr. Gladstone's creeds, as a statesman, it is which we must ascribe to the influence of Greek culture—whether the creed with which he set out as a Tory when fresh from Oxford, or the extreme radical creed which he has adopted of late years?

and says that Darius thought a Greek who kept his word a notable exception.

Evidence of the relation between chronic hostilities and utter disregard of truth, is furnished throughout the history of Europe. In the Merovingian period—"the era of blood"—oaths taken by rulers, even with their hands on the altar, were forthwith broken; and Salvian writes—"If a Frank forswear himself, where's the wonder, when he thinks perjury but a form of speech, not of crime?" After perpetual wars during the two hundred years of the Carolingian period, with Arabs, Saracens, Aquitanians, Saxons, Lombards, Slavs, Avars, Normans, came the early feudal period, of which H. Martin says:—

> "The tenth [century] may pass for the era of fraud and deceit. At no other epoch of our history does the moral sense appear to have been so completely effaced from the human soul as in that first period of feudalism."

And then, as an accompaniment and consequence of the internal conflicts which ended in the establishment of the French monarchy, there was a still-continued treachery: the aristocracy in their relations with one another "were without truth, loyalty, or disinterestedness. . . . Neither life nor character was safe in their hands." Though Mr. Lecky ascribes the mediæval "indifference to truth" to other causes than chronic militancy, yet he furnishes a sentence which indirectly yields support to the induction here made, and is the more to be valued because it is not intended to yield such support. He remarks that "where the industrial spirit has not penetrated, truthfulness rarely occupies in the popular mind the same prominent position in the catalogue of virtues" as it does among those "educated in the habits of industrial life."

Nor do we fail to see at the present time, in the contrasts between the Eastern and Western nations of Europe, a like relation of phenomena.

Reflection shows, however, that this relation is not a direct one. There is no immediate connection between bloodthirstiness and the telling of lies. Nor because a man is kind-hearted does it follow that he is truthful. If, as above implied, a life of amity is conducive to veracity, while a life of enmity fosters unveracity, the dependencies must be indirect. After glancing at some further facts, we shall understand better in what ways these traits of life and character are usually associated.

In respect of veracity, as in respect of other virtues, I have again to instance various aboriginal peoples who have been thrust by invading races into undesirable habitats; and have there been left either in absolute tranquillity or free from chronic hostilities with their neighbors. Saying of the Kois that they all seem to suffer from chronic fever (which sufficiently shows why they are left unmolested in their malarious wilds) Morris tells us that—

"They are noted for truthfulness, and are quite an example in this respect to the civilized and more cultivated inhabitants of the plains."

According to Shortt, in his *Hill Ranges of Southern India*—

"A pleasing feature in their [Sowrahs] character is their complete truthfulness. They do not know how to tell a lie. They are not sufficiently civilized to be able to invent."

I may remark in passing that I have heard other Anglo-Indians assign lack of intelligence as the cause of this good trait—a not very respectable endeavor to save the credit of the higher races. Considering that small children tell lies, and that lies are told, if not in speech yet in acts, by dogs, considerable hardihood is shown in ascribing the truthfulness of these and kindred peoples to stupidity. In his *Highlands of Central India*, Forsyth writes:—

"The aborigine is the most truthful of beings, and rarely denies either a money obligation or a crime really chargeable against him."

Describing the Râmósîs, Sinclair alleges that—

"They are as great liars as the most civilized races, differing in this from the Hill tribes proper, and from the Parwâris, of whom I once knew a Brâhman to say: 'The Kunabîs, if they have made a promise, will keep it, but a Mahâr [Parwari] is such a fool that he will tell the truth without any reason at all.'"

And this opinion expressed by the Brahman, well illustrates the way in which their more civilized neighbors corrupt these veracious aborigines; for while Sherwill, writing of another tribe, says—"The truth is by a Sonthal held sacred, offering in this respect a bright example to their lying neighbors the Bengalis," it is remarked of them by Man that—

"Evil communications are exercising their baneful influences over them, and soon, I fear, the proverbial veracity of the Sonthal will cease to become a byword."

In *The Principles of Sociology*, vol. ii, §§ 437 and 574, I gave the names of others of these Indian hill-tribes noted for veracity—the Bodo and Dhimáls, the Carnatic aborigines, the Todas, the Hos; and here I may add one more, the Puluyans, whose refuge is "hemmed in on all sides by mountains, woods, backwaters, swamps, and the sea," and who "are sometimes distinguished by a rare character for truth and honor, which their superiors in the caste scale might well emulate." So too is it in a neighboring land, Ceylon. Wood-Veddahs are described as "proverbially truthful and honest." From other regions there comes kindred evidence. Of some Northern Asiatic peoples, who are apparently without any organization for offense or defense, we read:—"To the credit of the Ostiaks and Samoieds it must be said, that they are eminently distinguished for integrity and truthfulness."

But now we have to note facts which make us pause. There are instances of truthfulness among peoples who are but partially peaceful, and among others who are anything but peaceful. Though characterized as "mild, quiet, and timid," the Hottentots have not infrequent wars about territories; and yet, in agreement with Barrow, Kolben says—

> The Word of a Hottentot "is sacred: and there is hardly any Thing upon Earth they look upon as a fouler Crime than Breach of Engagement."

Morgan, writing of the Iroquois, states that "the love of truth was another marked trait of the Indian character." And yet, though the Iroquois league was formed avowedly for the preservation of peace, and achieved this end in respect of its component nations, these nations carried on hostilities with their neighbors. The Patagonian tribes have frequent fights with one another, as well as with the aggressive Spaniards; and yet Snow says—"A lie with them is held in detestation." The Khonds, too, who believe that truthfulness is one of the most sacred duties imposed by the gods, have "sanguinary conflicts" between tribes respecting their lands. And of the Kolîs, inhabiting the highlands of the Dekhan, we read that though "manly, simple and truthful," they are "great plunderers" and guilty of "unrelenting cruelty."

What is there in common between these truthful and pacific tribes and these truthful tribes which are more or less warlike? The common trait is that they are not subject to coercive rule. That this is so with tribes which are peaceful, I have shown elsewhere (*Principles of Sociology*, ii, §§ 573–4); and here we come upon the significant fact that it is so, too, with truthful tribes which are not peaceful. The Hottentots are governed by an assembly deciding by a majority, and the head men have but little authority. The Iroquois were under the control of a council of fifty elected sachems, who could be deposed by their tribes; and military expeditions, led by chiefs chosen for merit, were left to private enterprise and voluntary service. Among the Patagonians there was but feeble government: followers deserting their chiefs if dissatisfied. Writing of the Khonds' "system of society" Macpherson says—"The spirit of equality pervades its whole constitution, society is governed by the moral influence of its natural heads alone, to the entire exclusion of the principle of coercive authority."

In the remarks of sundry travelers, we find evidence that it is the presence or absence of despotic rule which leads to prevalent falsehood or prevalent truth.

Reference to the *Reports on the Discovery of Peru* of Xeres and Pizarro (pp. 68–9, 85–6, 114–120), makes it manifest that the general untruthfulness described was due to the intimidation the Indians were subject to. So, too, respecting the Mexicans, the Franciscan testimony was—"They are liars, but to those who treat them well they speak the truth readily." A clear conception of the relation between mendacity and fear was given to Livingstone by his experiences. Speaking of the falsehood of the East Africans he says—

"But great as this failing is among the free, it is much more annoying among the slaves. One can scarcely induce a slave to translate anything truly: he is so intent on thinking of what will please."

And he further remarks that "untruthfulness is a sort of refuge for the weak and oppressed."

A glance over civilized communities at once furnishes verification. Of European peoples, those subject to the most absolute rule, running down from their autocrat through all grades, are the Russians; and their extreme untruthfulness is notorious. Among the Egyptians, long subject to a despotism administered by despotic officials, a man prides himself on successful lying, and will even ascribe a defect of his work to failure in deceiving some one. Then we have the case of the Hindus, who, in their early days irresponsibly governed, afterwards subject for a long period to the brutal rule of the Mahometans, and since that time to the scarcely-less brutal rule of the Christians, are so utterly untruthful that oaths in Courts of Justice are of no avail, and lying is confessed to without shame. Histories tell like tales of a mendacity which, beginning with the ruled, infects the rulers. Writing of the later feudal period in France, Michelet says:—"It is curious to trace from year to year the lies and tergiversations of the royal false coiner"; but nowadays political deceptions in France, though still practiced, are nothing like so gross. Nor has it been otherwise among ourselves. If with the "universal and loathsome treachery of which every statesman of every party was continually guilty," during Elizabeth's reign, while monarchical power was still but little qualified, we contrast the veracity of statesmen in recent days, we see a kindred instance of the relations between the untruthfulness which accompanies tyranny and the truthfulness which arises along with increase of liberty.

Hence such connections as we trace between mendacity and a life of external enmity, and between veracity and a life of internal amity, are not due to any direct relations between violence and lying and between peacefulness and truth-telling; but are due to the coercive social structure which chronic external enmity develops, and to the non-coercive social structure developed by a life of internal amity. To which it should be added that under the one set of conditions there is little or no ethical, or rather pro-ethical, reprobation of lying; while under the other set of conditions the pro-ethical reprobation of lying, and in considerable measure the ethical reprobation, become strong.

THE PREHENSILE FOOT OF EAST INDIANS.

By M. F. REGNAULT.

THE traveler who walks in the native quarters of the cities of India can easily study there all industries in their beginnings, as they were probably practiced in Europe in the middle ages. The shops are usually open, and the workmen can be seen inside; textile industries, pottery, shoemaking, joinering, armoring, jewelry, confectioners—all can be observed in a single street like Chitpore Street, Calcutta. If we take pains to examine attentively the methods of working, we shall be struck by the enormous function played by the lower limb. Whatever the industries, the Indian, squatting or sitting on the ground, works with his feet as well as with his hands; and it might be said that all four of his limbs are in constant exercise. The joiner, for example, has no assistant to hold his plank, but makes his great toe serve that purpose. The shoemaker does not employ a fixed clamp for the shoe on which he is sewing, but holds it in his feet, which change position to suit his convenience, while his nimble hands do the sewing. The metal-worker holds the joint of his shears on his feet in cutting copper.

In the making of wooden combs I have seen the comb held straight up by the feet, while the workmen marked the teeth with one hand and with the other directed the instrument that cut them. The wood-turner directs the hand-rest with his great toes; so, generally, do Egyptian and Arabian turners. In smoothing twine or sewing a bridle the Indians hold the article between the first and second toes. When the butcher cuts his meat into small pieces, he holds his knife between the first and second toes, takes the meat in both hands, and pulls it up across the knife. I have seen a child climb a tree and hold a branch between his toes. These are enough details concerning the constant, universal use of the foot.

In considering this property of the lower limb, it is well to distinguish between the parts that relate, first, to the articulation of the hip, which, being very loose, permits the Indian to squat in such a position that his foot shall not be very far from his hands, so as to make all four participate in the work and permit the whole lower limb to engage in wide movements. The position is very different from that of our tailors or of the Arabs. It brings the knees to a level with the chest. The man is supported on his ischia and his feet; and he keeps in this position for whole hours, while we can maintain it only for a few minutes. It is their way of resting, and we can see them by groups squatting in this manner, and smoking. In the second place, the articulation of the instep and the medio-tarsal permit wide lateral movements of the foot, as in

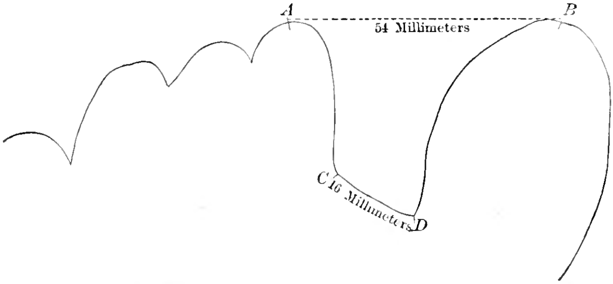

Fig. 1.—Showing the Enormous Distance between the First and Second Toes in a Tamil of Trichinopoly.

the examples of the shoemaker, joiner, comb-maker, and turner; and on the toes, which are peculiarly flexible, as with the butcher cutting meat and the child climbing trees.

The great toe is capable of considerable lateral movements from the second toe, so that the Indian can easily pick up articles from the ground with his foot, and even exert some force sidewise.

But great as is their skill, there is no movement of opposition between the great toe and the other toes, as there is in the monkey. The great toe has very extended movements of adduction and abduction, and of elevation and depression, but all is limited.* The property is frequent among savages and half-civilized peoples. Broca pointed out in 1869 the part which the foot could be made to serve. Morice has remarked that the great toe of the Annamites could be used by them in picking up small objects; and he saw a boatman take his hand from the helm and steer very correctly with his foot, while he rolled his cigarette.†

In French and foreign treatises on anthropology I find Ranke's work, entitled *Der Mensch*, the only one in which the function of the toes as organs of prehension is mentioned; and the feet of Japanese rope-dancers and jugglers have been examined with reference to this point by Luce.‡ But the constant use

* Sir Richard Wallace says that, with all the savages he ever saw, he never observed movements of opposition.

† Bulletin de la Société d'Anthropologie, session of the 18th of February, 1875.

‡ Travelers have often mentioned similar facts in their narratives. Horsemen in Abyssinia, according to G. Pouchet, hold the straps of their stirrups between the first and sec-

of the foot in the industry of a people advanced in civilization does not appear to me to have been remarked.

The Ectromelians are able to use their feet after a long and patient education, but they seem to serve the part of supplementary organs. A report has been made to the Society of Anthropology (Bulletin, 1875) concerning the Ectromelian Ducornet, who, with only four toes, painted, holding his brush between his two middle toes. I saw one who was exhibited at Marseilles in 1889. He drank, ate, fired guns, played cards, wrote, and played on several instruments of music with his feet. On a closer examination of him it appeared, as is observed in all similar cases, that there was no movement of opposition of the great toe. A special anatomical peculiarity is connected with this physiological function of the foot—the distance between the first and second toes. Let us look into this feature among the Indians, taking for our example the extremely remarkable type of Fig. 1. It represents the foot of a Tamil in Trichinopoly, in which the space be-

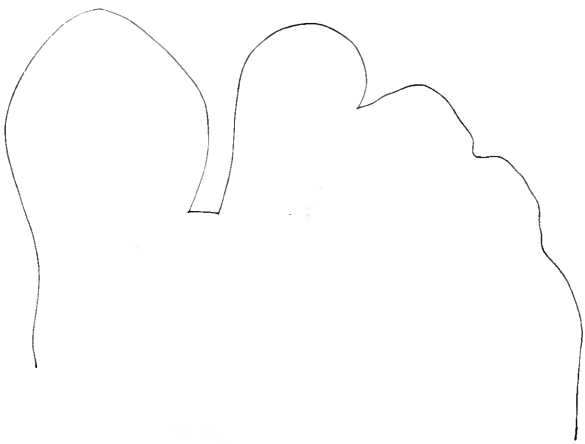

Fig. 2.—Nearest Possible Approach of the First and Second Toes in the same Tamil.

tween the first and second toes was very large from birth. Taking the middle of the extremity of the first and the middle of the second toe, I measured the two points A and B, the distance between which, on a foot placed in its usual position on the ground, was forty-nine millimetres in the right foot and fifty-four millimetres in the left foot. This does not depend upon a simple divergence of the ends of the toes; the base participates in it, and it seems to go back to the metatarso-phalangeal articulation. This distance apart of the toes at the base is fifteen millimetres on the right and sixteen millimetres on the left foot. When this Tamil

ond toes. In New Guinea, says D'Albertis, natives secure themselves in walking by hooking their great toe to a root or a bit of rock.

was asked to bring the two toes as near together as possible, he could not make them touch; there was still a space between them, as in Fig. 2. All gradations may be observed between this maximum of separation and a foot on which no separation can be perceived in ordinary attitudes.

Among thirty-seven persons examined in Pondicherry, I only found eight in whom there was a separation. It is therefore not constant in the Indian race. The distance between the ends of the toes may vary in the same person by ten or even by twenty millimetres, accordingly as they are drawn together or apart by the muscles of the foot alone, and without using the hand. They may usually be made to touch when brought together. But it will be observed that they only touch at the ends. At the root the separation persists. The distance between the toes, there, may be diminished, but does not vanish, when they are brought together, and it may be increased when they are spread out.

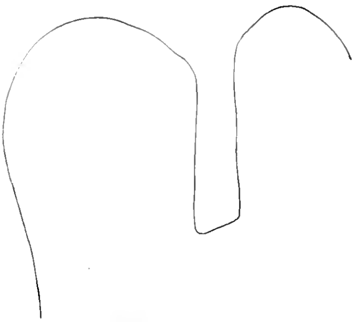

Fig. 3.—Normal Position of the Foot.

Figs. 3, 4, and 5 illustrate these facts. They are accurate, being the traces, taken with a pencil, of the toes in different positions; and it should be kept in mind that the separation and the drawing together are due solely to the action of the muscles of the foot.

This anatomical disposition may occur in other Indians as well as in Tamils. I have found it among the Bengalis, in three of whom I have drawn it, but it is not frequent among them. With none, however, in all my investigations, have I found it as strongly accentuated as with the Trichinopolitan whom I have used as a type. It appears to be rare among the Singhalese, but their feet have the prehensile property.

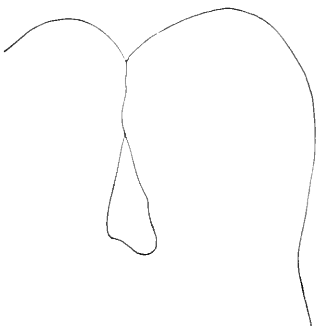

Fig. 4.—The same, with the Toes brought together.

An interesting point in the feature is the possibility, by means of it, of using a peculiar patten, which consists of a flat piece of wood cut in the form of the foot, with a peg between the first and second toes, by which the shoe is held on. It is used only in the low castes. Four pairs of these pattens may be seen in the collection of shoes in the Cluny Museum. In two of them the peg is tipped with an ivory button, one having four lobes and the other six, which give them a resemblance to a lotus flower. These lobes open under the pressure of the foot, and thus form a kind of fastening. Pattens of this kind are used only in the Indies. A European would find it very hard to wear them.*

The separation of the great toe at the base is not special to the East Indians. M. Manouvrier has reproduced it on two drawings of the feet of Caribs on exhibition in the *Jardin d'acclimatation;* but this author has not observed that the foot has any special part with this people as an organ of prehension. Among the numerous casts of feet in the museum of the *Société d'Anthropologie* are some very interesting impressions of the feet of Annamites, presented by M. Mondière. The separation on the foot of one of these Annamites, named Van, is very marked. It measures twelve millimetres at the base of the first and second toes, and forty-one millimetres, taking the middles of the nails as points of measurement, at the tips (Fig. 6). On the impression of the foot of another Annamite, named Thi-Finhi, the separation is less notable, but is still four millimetres at the base and forty-one millimetres at the ends; while a third impression, still by M. Mondière, shows a still different degree of separation. This separation has been noticed frequently among the Annamites, as well as the prehensile faculty of the foot. They therefore enjoy that property in common with the Indians.

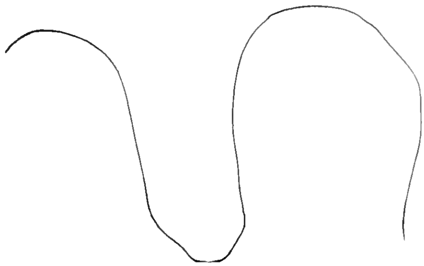

Fig. 5.—The same, with the Toes spread out.

It does not follow, however, that this faculty is common to all peoples that go barefooted, or even to all savages. There are at the museum castings of three feet of negroes in which nothing like it appears; an American Indian foot from the lower Amazon, the gift of Dr. Crevaux, also normal; two feet of young Bushmen, normal likewise; and thirteen feet of Fuegian men and women, normal. Only in the cast of the right foot of one young

* The pattens worn in China, Japan, and Burmah somewhat resemble these. They, too, can be seen in the Cluny Museum. Three of the specimens there were held to the foot by strings, one part of which was fixed to the shoe between the first and second toes, while the other part, passing over the back of the foot, ended in the side of the shoe. These sandals resemble those of the ancient Greeks and Romans, as we see them in works of art. The separation of the great toe from the others in Japanese stockings is explained by this construction. It is to enable the pattens to be put on. But the abduction force of the great toe is not utilized in these as it is in the Indian pattens. The shoe is held by strings to the sole of the foot.

man did I find a separation of four millimetres at the base of the first two toes. The *École d'Anthropologie* has several traces of feet taken by M. Manouvrier among Fuegians, Araucanians, Omahas, and Arabs of Algeria and Morocco, in none of which is there any example of this anatomical peculiarity. I have not observed it in any European or in any white child.* The habit of walking barefooted may produce a slight divergence of the great toe, but not at the base. The function of prehensibility must therefore be considerably developed for such a divergence to exist. Still, heredity appears to have a part in it; for we do not observe it except among peoples who have exercised the function from a remote antiquity. It would be interesting to dissect a foot presenting this formation and compare it with the foot of a white. We should most likely find the oblique and transverse abductor muscles very highly developed. It is a current fact that exercise strengthens the muscles.

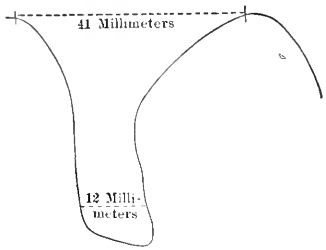

Fig. 6.—The First and Second Toes of the Annamite Van.

It would also be desirable to learn the origin of the separation at the base of the first and second toes. It can not be caused, as in the monkey, by the head of the first metatarsal playing on that of the second, for there is no movement of opposition here. It all takes place in the metatarso-phalangeal articulation. M. Testut, in a work on the Quaternary skeleton of la Chancelade, remarks that the anterior articular surfaces of the metatarsi which are destined for the phalanges are more extended, in length as well as in breadth, than those which have been observed on the metatarsi of European races. Unfortunately, we have data only for the articular surfaces of the last four metatarsi—the first, the one that interests us, having probably been suppressed. M. Testut concludes that this disposition is related to the mobility of the toes on the metatarsus—a mobility which has probably been considerably diminished in man since he has made his foot exclusively an organ of support. Whether the skeleton of the Indian is like this, and whether the separation of the base of the toes can be explained in this way, suggest hypotheses which dissection alone can verify.

The examination of the prehensile foot suggests forcibly the thought of comparing it with the foot of the monkey. The difference between the opposable foot of the monkey and the foot of man has been variously explained. The non-transformists base

* The movements of the toes are well developed in new-born children; but I have never observed, in children's hospitals, any trace of opposition.

upon it an argument against the application of the transformist theory to man. Some Darwinians believe that if man used his foot constantly and generally as a prehensile organ, an opposition of the great toe would be gradually evolved in the adaptation of the organ to that function. The preceding study, however, proves that this is not the fact. Among a people who have for centuries commonly used their feet as a prehensile organ no movement of opposition has been produced; while in some persons an adaptation to the new function has been observed, namely, a separation of the great toe and wide and strong lateral movements, but only lateral—a pincers-foot, not a hand-foot. It will be seen, on reflection, that the condition could not be otherwise.

In walking, the weight of the body is borne on the heads of the five metatarsi, but mostly on the head of the first one. If that was not united solidly to the second metatarsus, and could turn around it as is done in the hand, it would give way every time the foot touched the ground, and the foot would want a sufficient internal point of support; walking would still be possible, but it would be hard and laborious—occasional, and not a habitual normal act. It is thus with the monkey, which is supported solely on the outer edge of the foot. Even the anthropoid walks rarely and awkwardly; its foot, adapted to living in the woods, has the opposition movement convenient for climbing easily; it has a foot-hand. The man who, continuing to walk, likewise wants a prehensile foot, can not enjoy this movement, which is incompatible with walking. He satisfies himself with lateral movements between the great toe and the second toe, or a pincers-foot. All this is simply a consequence of the general biological law of the adaptation of the organ to the function.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

A curious, secretive proceeding of swans is described in Nature by Jessie Godwin-Austen. The cygnets having been just hatched out, the male bird picked up an empty half egg-shell lying beside the water and carefully carried it to the edge of the water some twenty feet from the nest, filled it with mud, and pushed it into the river, where it sank to the bottom; and then repeated the performance with the other half egg-shell. On returning to the nest the last time, he placed a few sticks across the small track he had made. As no other pieces were seen about the nest, while five cygnets were hatched, it is inferred that the bird had done the same with all the egg-shells.

A paper by Mr. Edward Dobson, in the Australasian Association, on Human Habitations in Prehistoric Times, was devoted to showing that, while rectangular forms prevailed in the early buildings of the East and in North America, the circular form had prevailed throughout Africa (with the exception of the Nile Valley) and through Switzerland and northern Europe, in Lapland and Greenland; and raised an inquiry as to the causes of these facts.

MANUFACTURE OF BOOTS AND SHOES.

By GEORGE A. RICH.

XVI. DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS.

WITH all the uses to which leather is put, that of making boots and shoes is the most important, and calls for the greater part of the product of the tanneries of the country. It is not only the most important in point of magnitude, but it is one which has opened an unusual field for American ingenuity and invention. When the late Charles Stewart Parnell was in this country some years ago, he expressed a desire to see what could be done in an American shoe-factory. Accordingly, what is known to the trade as a Polish lace boot was selected by the Lynn manufacturer, whose building Mr. Parnell was inspecting, as the pattern to illustrate the processes of the art and the speed of the work. Mr. Parnell hastened from one part of the factory to another as the boot in its evolution flew hither and thither, and within twenty minutes after he had seen the pattern placed upon the leather the finished article was handed to him. That, of course, was an exhibition not practicable in ordinary, every-day work. But, compared with the time it would have required to make the boot by hand, it points to the saving that has been effected through the introduction of machinery and emphasizes the mechanical and economical development of the industry. As in the case of tanning, these advances are of comparatively recent origin, dating largely from the civil war and the scarcity of labor consequent upon it. But, though brief the time, the advance from the shoemaker of forty years ago with his hammer and lapstone, to the factory of the present day with its multiplicity of machines and its hundreds of operatives, has been a wonderful one. Indeed, within that period is crowded more in the way of progress and development than is to be found in all the centuries which intervene between the time of the Egyptian cobbler and that of our grandfathers.

There is no article of dress in which more striking changes have been made in the various ages than in the covering for the feet. Until the law was invoked, boots and shoes seemed to be the special field in which the whims of fashion manifested themselves. Coverings for the feet must have been among the earliest articles of dress. It is almost impossible to conceive of a time when ever-recurring injuries from contact with the earth's surface did not suggest some such protection. The primitive form of foot-covering was the sandal, which was simply a flat sole under the foot and secured to it by a thong. These were made of a great variety of materials. The Egyptians used palm leaves and leather, while the Hebrews preferred linen or even wood. Brass and iron were not found objectionable by some, and in a few instances gold was employed for that purpose. Like the sandal, the shoe grew out of physical conditions, the fundamental purpose of it being protection for the whole foot. Among the early Greeks and Romans shoes were not common, but the wearing of them once established, an endless variety arose—law and fashion dictating special styles and finish for the several social ranks and classes. A single hide, slit and looped into a purse-like pouch by a thong run through it, seems to have been the primitive form of the shoe in Great Britain. Boots and shoes became common in Europe between the ninth and sixteenth centuries, and the fantastic forms which they assumed,

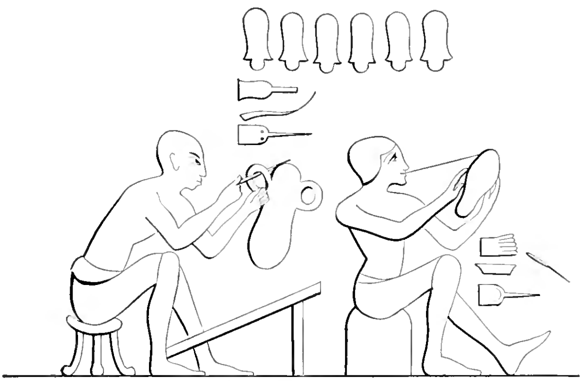

FIG. 1.—ANCIENT EGYPTIAN COBBLERS AT WORK. The familiar awl, lapstone, and thread appear in this. Even the method of drawing the thread is not unknown to those who have ever frequented an old New England cobbler's shop.

and the laws in restraint of them, show the prominent place they had come to occupy in the wardrobe and fashions of the day.

It was not to be expected that there would be a serious demand on the part of the early settlers in this country for these more fashionable styles of boots and shoes. Those who could afford to do so brought with them such articles for holiday and Sunday use, just as they did their velvet breeches and brocade gowns and bits of old lace. But there was a need from the first for stout boots and shoes, both as a protection against the cold and against injury on the rocks and rough soil. Some of the settlers were quick to adopt the moccasin of the Indian; but, though warm and easy to make, it did not meet the ideas of the Europeans. Accordingly, the shoemakers were among the first craftsmen to settle here, and from the privileges that were accorded them from the start their number and influence may be inferred. The early records of Virginia, New York, Pennsylvania, and Massachusetts all bear evidence to their presence and to the establishment of their trade.

But it was in the last State, at Lynn, that the industry had its real origin and center in this country.

Philip Kertland was the first person of that craft to locate in what was to develop into the "City of Shoes," coming thither from Sherrington in Buckinghamshire, England, in 1638. He was joined soon after by Edmund Bridges, and considerable of a local business sprang up. At that time shoemakers went around from house to house and worked up the family stock of leather, but this itinerant system was soon dropped by the Lynn craftsmen as their business grew into more than a local one. The art of shoemaking, however, was not understood and the workmen were unskilled. Occasionally some of the more ambitious ones would send to England for shoes and take them apart, with a view of learning the way of making them. But men who had money and were in a

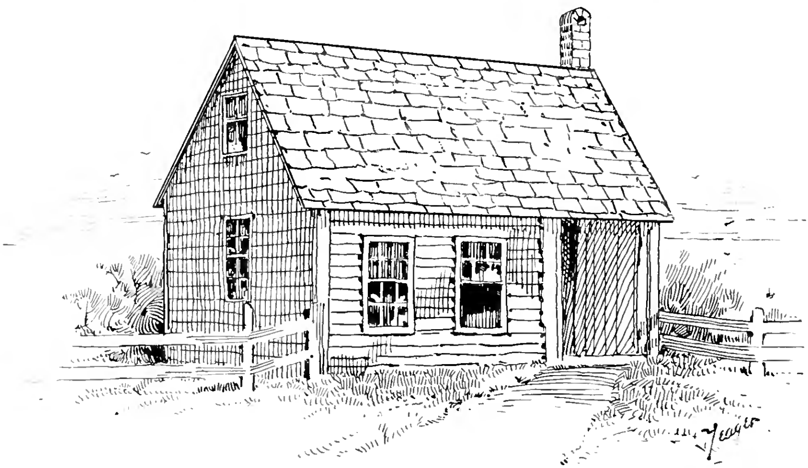

FIG. 2.—AN EARLY LYNN SHOE-SHOP. These shops marked the intermediate stage in the evolution of the shoe industry. With the introduction of machinery, between 1860 and 1870 they passed out of use and largely out of existence.

position to help on such experiments were shy of the shoe business. They preferred to invest in trade and real estate. The result was that no real progress was made in the business until John Adams Dagyr, a Welsh shoemaker, moved to Lynn in 1750. Dagyr was skilled in the methods employed in England, and he proceeded to instruct all who came to him in the art. His fame spread abroad through northeastern Massachusetts, and it was only a short time after his settlement before a notable improvement became apparent in the Lynn product. The Boston Gazette of October 21, 1764, said: "It is certain that women's shoes, made at Lynn, do now exceed those usually imported, in strength and beauty, but not in price." Edward Johnson, of Woburn, in his "Wonder-working Providence," says of Lynn: "All other trades have fallen into their ranks and places, to their great advantage, especially coopers and shoemakers, who had either of them a corporation granted, enriching themselves by their trades very much. As for tanners

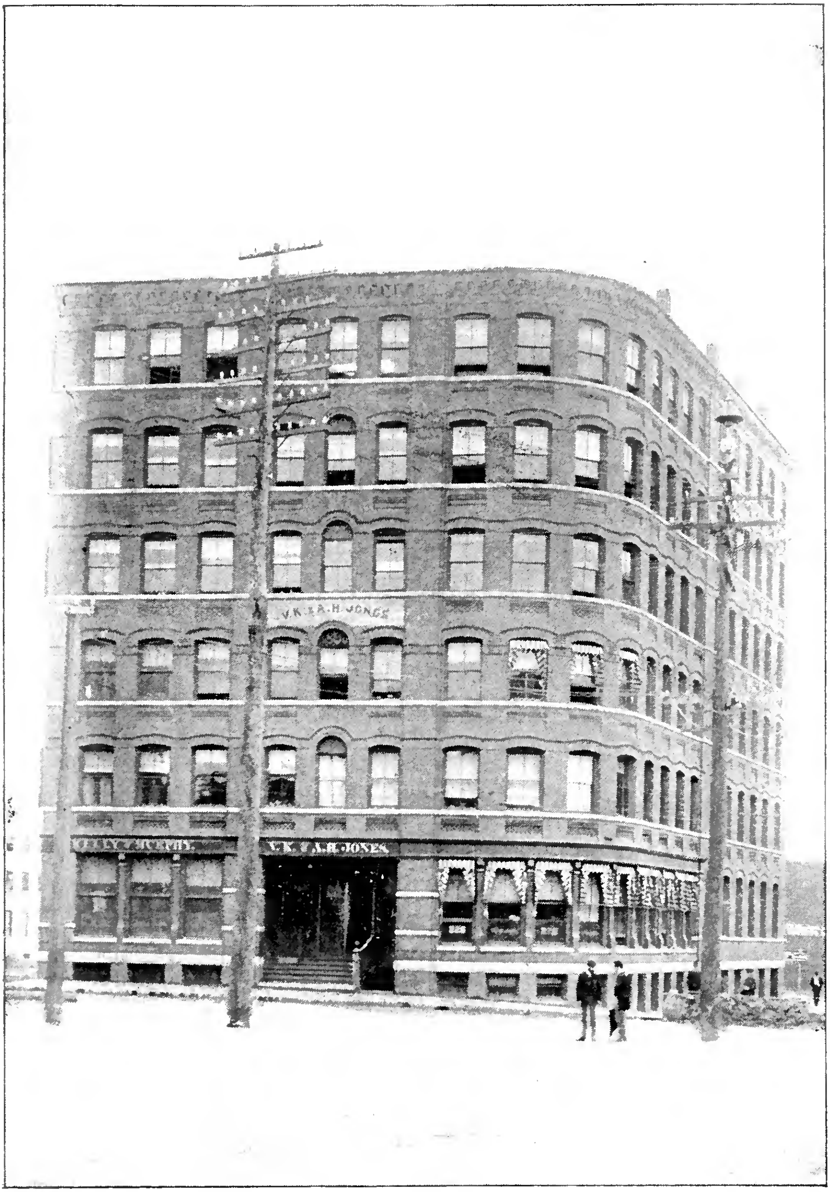

FIG. 3.—A FACTORY OF TO-DAY.

and shoemakers, it being naturalized into their occupations to have a higher reach in managing these manufactures than other men in New England are, having not changed their nature in this, between them both they have kept men to their stand hitherto, almost doubling the price of their commodities, according to the rate they were sold in England, and yet the plenty of leather is beyond what they had there, counting the number of the people. But the transportation of boots and shoes into foreign parts hath vented all, however."

Inasmuch as this was written only a year after Dagyr's arrival at Lynn, it is pretty safe to set Mr. Johnson down as something of an optimist. But it points to the immediate impetus the industry received under the latter's hand. Yet, by a strange irony, Dagyr, who did so much to establish the shoemaker's art in this country,

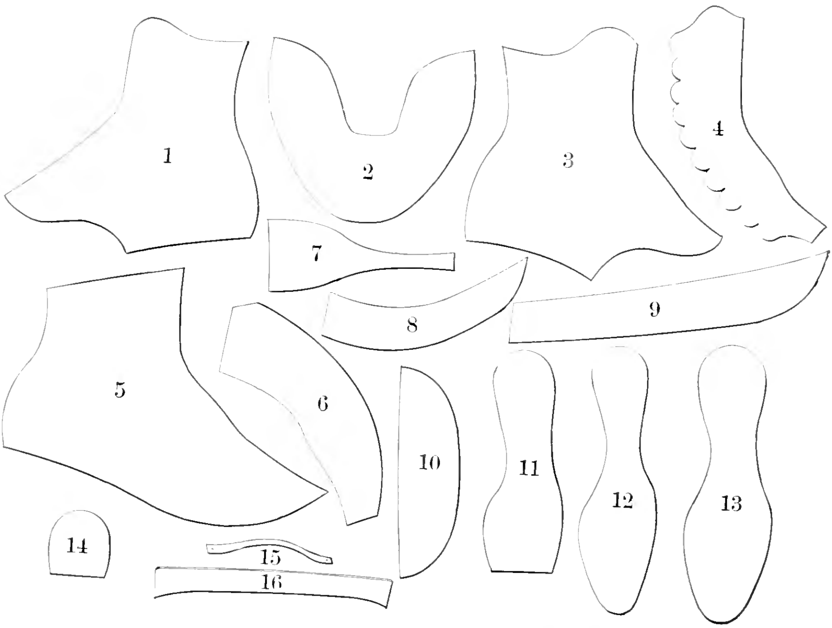

Fig. 4.—Parts of a Button Shoe. 1, Large quarter; 2, vamp; 3, small quarter; 4, button piece; 5, drill lining; 6, glove button-piece lining; 7, heel lining stay; 8, button stay; 9, top stay; 10, heel stiffener; 11, sole lining; 12, inner sole; 13, outer sole; 14, heel lifts (six); 15, steel shank; 16, rand.

died in the Essex County almshouse. The principal part of the work at that time was done in little, one-story shops. The rooms were scarcely more than a dozen feet square, with windows at sides and end and a broad fireplace in one corner. They were good-natured, industrious, thrifty companies that filled those shops. Fishermen and farmers and those trained "to the last" were all represented. Journeyman and apprentice, master and workman, stood on the same footing and shared alike. These shops stand, economically and mechanically, between the home and the factory. Shoes were still sent to the houses of the farmers to be finished, and some of the shops turned out work enough to entitle them to the more ambitious name which is attached to such establishments at the present day. Other towns about Lynn followed its lead; and Marblehead, Danvers, and Haverhill soon became actively engaged in the industry. Women's shoes were then—as they have ever continued—the staple article of manufacture at Lynn. These were made largely of stuff, the finer qualities with white and russet rands, stitched firmly with white waxed thread, pointed at the toes, and adorned with wooden heels covered with leather.

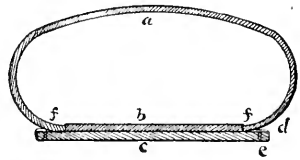

FIG. 5.—SECTION OF A MAN'S BOOT. *a*, The upper; *b*, in-sole; *c*, out-sole; *d*, welt; *e*, the stitching of the sole to the welt; *f*, the stitching of the upper to the welt.

That England felt this growing industry of the colonies is shown by the fact that a commission was appointed to inquire into the reason why no more boots and shoes were exported to America. It was with astonishment that the gentlemen composing the commission reported to their colleagues that the colonists were supplying their own foot-wear, and apparently, too, with satisfaction to those concerned. Then came England's desperate efforts to force the trade of the colonies into British channels and the consequent resistance of the latter to such coercion. Under the influence of the import duties, the shoe industry flourished especially, and at the time of the Revolution the manufacturers were unable to meet the demands which were made upon them for boots for the Continental army. But following that came a serious check. The American markets were flooded with English goods, and trade was paralyzed. A demand was then made on the part of the shoe manufacturers for some kind of protection, with the result that, in the first Congress, in 1789, a tariff was arranged so as to check importations. Hon. John B. Alley, of Lynn, at a leather-trade dinner in New York in 1859, gave somewhat of a romantic version to that portion of the tariff affecting boots and shoes—a version which possibly is not to be accepted in detail as history, but which is, nevertheless, of interest. He said that this early duty on imported boots and shoes was due largely to the efforts of Ebenezer Breed, a young Lynn shoemaker, who had located in Philadelphia on account of the dull times in his own town, and of his friend Stephen Collins, a native of the same place. By their influence with members of Congress and with Dolly Payne, the young Quakeress, to whom Mr. Madison, then a rising man in public legislation, was at that time paying attention, they got this boon for their home industry. Be that as it may, with the cessation of imports the Massachusetts shoe-shops began to expand rapidly, and goods were shipped not only to Boston, New York, and Philadelphia, but even to Liverpool. Lynn, in 1788, exported 100,000 pairs of shoes; while, seven years later, the volume of transactions had increased to 300,000 pairs, and there were at that time 200 master workmen and 600 journeymen and apprentices engaged in the making of them.

But, with all this development of trade, boots and shoes continued to be made by hand. Spasmodic attempts were made to abbreviate the processes, but nothing satisfactory resulted from them for many years. Mr. David Knox, writing in a shoe journal of his experiences as a manufacturer, says: "In 1855, the year in which I commenced business, about the only machinery used in shoe manufacturing were the sewing machines to stitch uppers and the machines to strip leather and cut it into soles. Even these were not in general use. Some manufacturers had introduced revolving cutters—in Lynn the Richards and Foster machines, and in Marblehead the Thompson. With the Foster and Thompson machines soles could be cut reasonably quick, but such was the risk of the operator's fingers being chopped off by the erratic movements of the knives that the old Thompson or Ingalls beam was preferred. By very hard work on these machines about fifteen pairs of soles could be cut per minute, while on the modern machines, operated by steam-power, as many as ninety pairs are cut in the same time, and with vastly more accuracy."

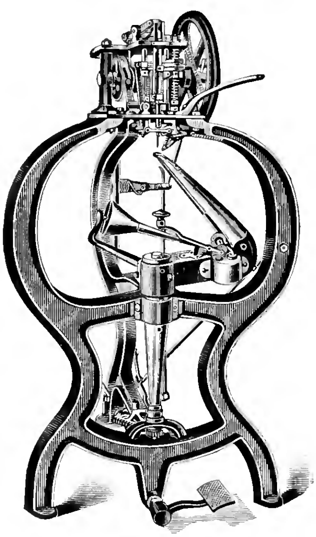

Fig. 6.—McKay Stitching Machine.

The chief tools of the shoemaker then consisted of his hammer, his awl, his lapstone, his knives, and his harness for "setting-up" his boots or shoes. The essentials of a shoe are the upper, the sole, the counter or heel stiffening, and the heel. These parts are again subdivided into the "vamp" for covering the front of the foot, the large and the small quarters for encircling the ankles, the button-piece, etc. The work of the shoemaker is to prepare and close these various parts of the upper and the linings together, to bring them into the desired shape, to fasten them to the sole which has been previously cut, to attach the heel, and then to give the various parts the desired finish and style. These processes indicate the lines along which machinery had to be applied. All the operations have been subdivided to the minutest detail, and in the performance of all of them machines—more or less satisfactory in their workings—have been devised. The parts of the uppers are now sewed together by machinery, and they are pegged, sewed, or screwed to the sole by machinery. Instead of the lapstone and the hammer for condensing the leather are now swiftly revolving rollers, and instead of the patterns for cutting out the soles are dies or sole-shaped knives set in machines.

But the field of shoe machinery is such a wide and complex one that it will be impossible to do more than glance at what may be termed the epoch-making inventions. The first great step was made when the sewing machine was invented and the alert manufacturers were able to turn it to their purposes. But the distinction of the sewing machine does not belong to the shoe manufacturers. The invention, however, which did determine their future was that which led to the fastening of the sole of the shoe to the upper by machinery. The solution of this problem had been the real difficulty in the way of applying machinery to the work, and when it had been met the single-story shoe-shop had made way for the factory; its dozen journeymen had lost their individuality in the hundreds of operatives, and the pin-money which the wives of the farmers, or the farmers themselves, had made from the job-work doled out to them by the manufacturers had become a thing of the past. From that dates the shoe industry of to-day. From it also have come the growth and prosperity of important communities in Maine, New Hampshire, and Massachusetts, in New York, Pennsylvania, and the older West. As in the solution of most such problems, it was not hit upon at once. There were failures which were the forerunners of nothing, and failures which were the forerunners of success.

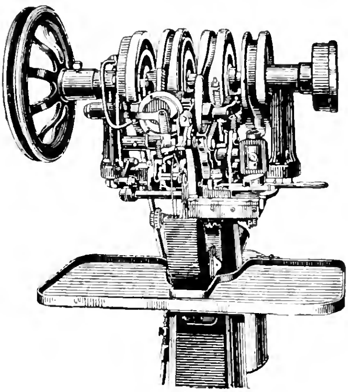

FIG. 7.—GOODYEAR STITCHING MACHINE. This is one of the machines in what is termed the Goodyear welt system.

Two of these latter are worthy of note, as they contained within them the suggestions which, a half-century later, were put into practical operation. The first of these attempts was made in 1809 by David Meade Randolph. He devised a way for fastening the soles and heels to the inner sole by means of nails. His plan was to use lasts covered at the bottoms with metallic plates, so that the nails, when driven through the soles, were clinched on this piece of metal. The next year Mark Isambard Brunel, the eminent engineer, carried this idea a step further. He

Fig. 8.—Scene in a Stitching Room.

fastened the soles to the uppers by nails, and, in order to do this, the leather was pressed between clamping plates of the same shape as the sole, the margin of the plate acting as a guide for a knife by which the sole was cut to the desired pattern. This sole was afterward clamped to a last, and there brought under the action of an awl and plunger operated by a lever. The sole-fastenings, usually nails, had to be placed in these awl-holes by hand, and were then driven in by the plunger, the awl at the same time making another hole for the next nail. Devices were also made for spacing the holes and clinching the nails on the inside of the shoe; but the shoes thus made proved unsatisfactory, the nails in them working loose.

In the actual solution of this problem two courses were pursued, the extension of the principle involved in the Randolph and Brunel devices and the application of the principle of the sewing machine. From the development of the one have come the pegged, nailed, and screwed boot and shoe; from the other, the stitched ones. In point of order the pegging machine came before the sole-sewing machine, standing as the invention of A. C. Gallahue, and under the date of 1851. Its operations were essentially the same as those of the cobbler who pierces the hole through the sole of the boot before him with his awl, and then, taking a peg from the generous store with which he has previously filled his mouth, drives it home with his hammer. Joseph Walker, of Hopkinton, Mass., had invented the shoe-peg about 1818, and it had commended itself to the craft at once. Machines were made for the manufacture of the pegs, and so thrifty were some of those engaged in their production that it is said they were sold in certain sections of the country not only as shoe-pegs but as a new kind of oats. Gallahue's machine included a cylinder on which were wound, like the spring of a watch, ribbons of birch of the same width as the length of the peg and sharpened on one edge. These were fed to the machine which, with knife, awl, and plunger, split the strips into widths of a peg, made a hole in the sole, and drove the peg into the shoe jacked beneath. Gallahue's invention was perfected by Messrs. E. Townsend and B. F. Sturtevant, of Boston. This idea has been still further developed in machines for riveting the two parts of the shoe together, the nails being clinched by coming in contact with an iron last, in a way suggestive of Brunel's method, and in machines for screwing them together. The screw machine, which came into use about 1875, is provided with a reel of stout screw-threaded brass wire, and this by the revolution of the reel is inserted into and screwed through the out-sole, upper edge, and in-sole. Within the upper a head presses against the in-sole directly opposite the point of the screw, and, when screw and head touch, the wire is cut level with the out-sole.

The first decisive step in sewing the sole and upper together was taken by Lyman R. Blake in 1858, his machine being perfected as the McKay sole-sewing machine. The machine, as described by Blake in his application for an English patent, "is a chain-stitch sewing machine. The hooked needle works through a rest or supporting surface of the upper part of a long, curved arm which projects upward from the table and the machine. This

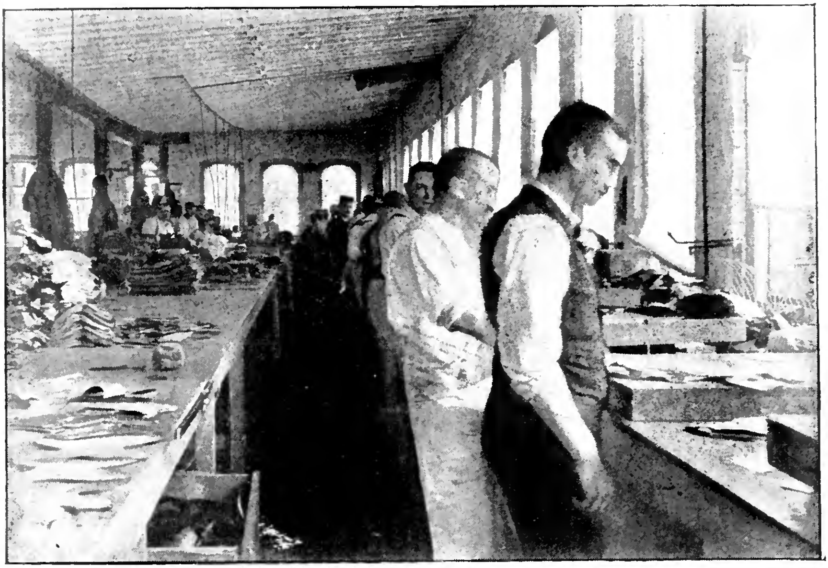

Fig. 9.—The Cutting Room.

arm should have such a form as to be capable of entering a shoe so as to carry the rest into the toe part as well as any other part of the interior of it. It carries at its front end and directly under the rest a looper, which is supported within the end of the arm so as to be capable of rotating or partially rotating round the needle, while the needle may extend into and through the eye of the looper, such eye being placed in the path of the needle. The thread is led from a bobbin by suitable guides along the curved arm, thence through a tension spring applied to the arm, and thence upward through the notch of the looper. The feed-wheel, by which the shoe is moved along the curved arm during the process of sewing, is supported by a slider extending downward from the block and applied thereto so as to be capable of sliding up and down therein. The shoe is placed on the arm with the sole upward." In less technical language, the machine consists of a combination of wheels so arranged as to drive an awl-like needle through several thicknesses of heavy leather, and feed a waxed thread in any direction. The shoe itself rests upon the end of the arm or horn noted in the above description, from the interior of which is supplied the waxed thread previously heated by a gas-jet within. But Blake's first machine was very imperfect. A leading interest in the invention, however, happened to fall into the hands of Mr. Gordon McKay. Realizing the importance of the principle, the two set themselves to its improvement. As perfected, they got patents on it in 1860, which gave them the practical control of the machine-made boots in this country for many years. It is said that nearly two hundred thousand dollars were spent on the invention before anything was realized from it. But when the return came it was indeed a golden harvest. None of the machines were sold outright to manufacturers, but they were let to them on the payment of royal-

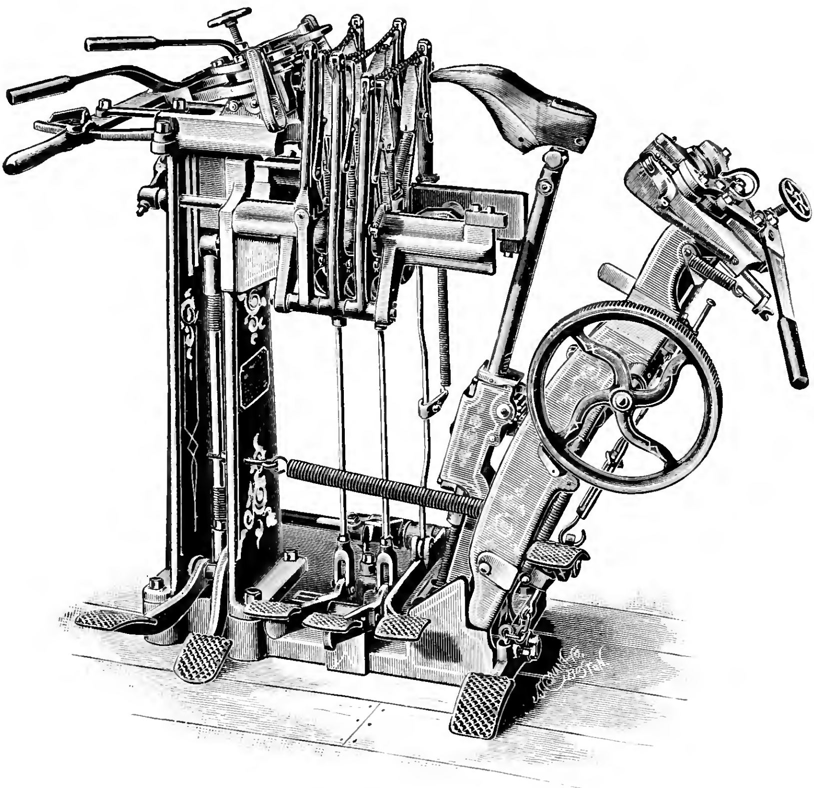

FIG. 10.—COPELAND RAPID LASTER.

ties; and to show what that amounted to is the fact that one Lynn manufacturer in a single year paid the company fully fifteen thousand dollars for the use of McKay machines in his shop. Under the pressure of the war the demand for boots and shoes of stout quality but cheaper grade was enormous, and it

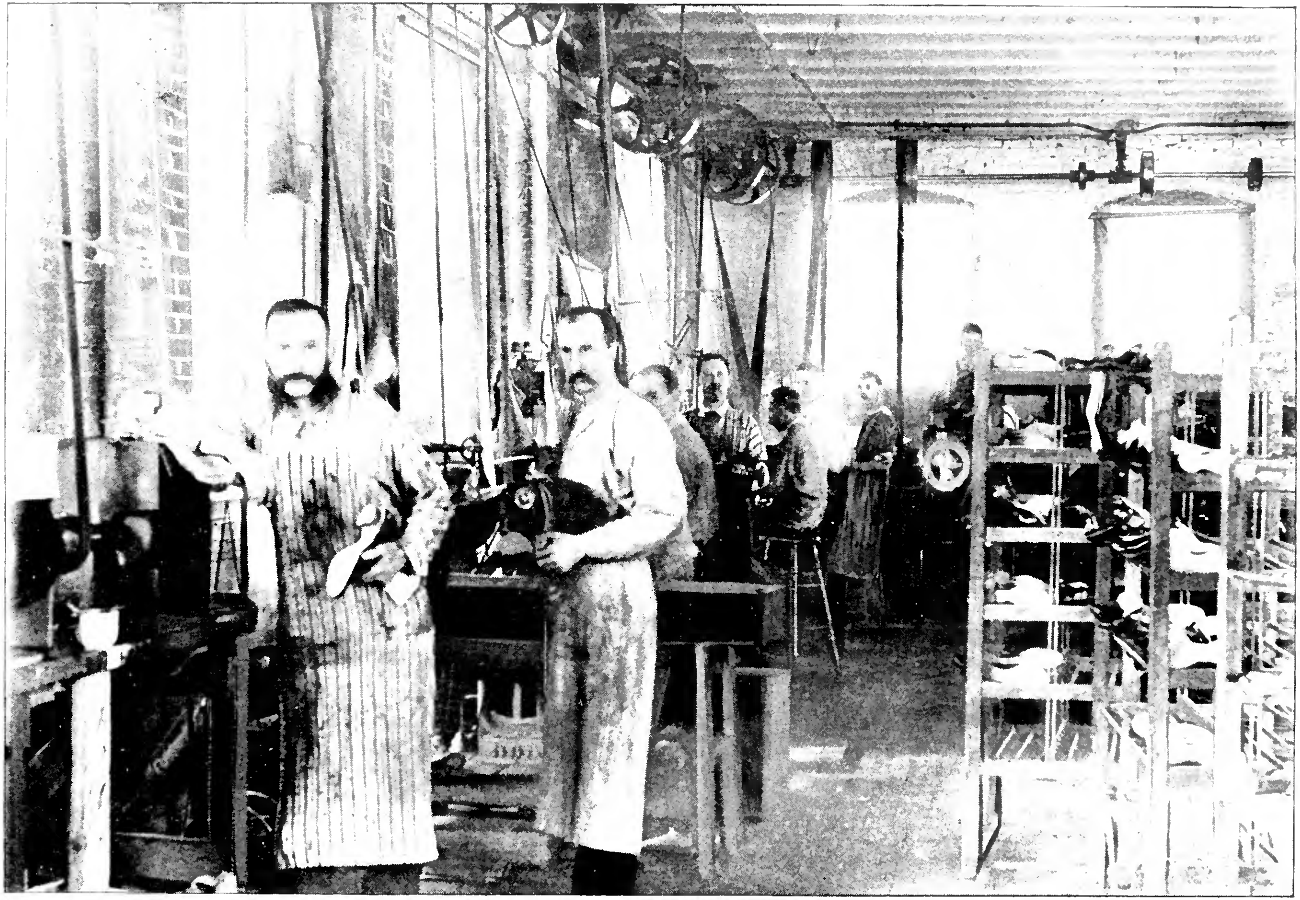

Fig. 11.—Putting on the Heels.

was largely to that class of work that the McKay machine was turned.

The close way in which the McKay machine was held tended to check further improvements for a time. The suggestions afforded by it and its success, however, were open to all, and several inventions were later offered to the public. Most important among these were the Goodyear and McKay machines for welted sewing, the first mechanism for stitching the soles on lasted shoes. In Fig. 5, which represents a section of a boot, *a* is the upper, *b* the in-sole, and *c* the out-sole, while *d* is the welt, *e* the stitching of the sole to the welt, and *f* the stitching of the upper to the same. Following the process of lasting—that is, after the upper has been carefully drawn over the last—the welt is put in position around the sides up to the heel. The thin edge of this is then caught together with the upper and inner sole. The out-sole is afterward tacked to the in-sole and, through a narrow channel made around the edges of it, sewed to the welt. The difficulties in the way of getting a machine which would do this, not simply as well as the hand, but do it at all, were many. The method which finally succeeded originated in a patent secured in 1862, by August Destory, for a curved-needle machine for sewing out-soles to the welts; but the machine did not work satisfactorily until it was taken in hand by Charles Goodyear, the son of the inventor of the India-rubber processes. This machine simply transforms the swinging movements of the hand and forearm in sewing into lateral and vertical ones, but the principle in the two operations is identical. There is one difference which in a way may be said to be even a point in favor of the machine sewing. In hand sewing the thread is drawn clear through its full length each time, and thus is weakened by constant wear. In the machine, only so much is drawn through as is necessary to form the stitch. These machines have been perfected and multiplied until what is known as the Goodyear system is the result. This system includes machines for sewing the welt on, attaching the sole to the upper, for lasting the upper, for

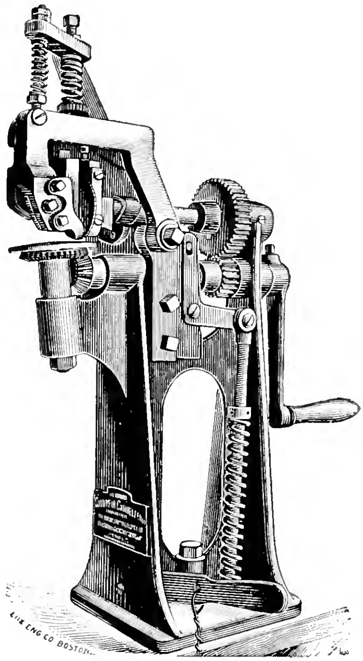

Fig. 12.—In-sole Channeler.

channeling or making the groove in which the stitching uniting the sole and upper runs, and for sewing turned shoes or work in which there is only one flexible sole attached to the upper, and done with the outside turned in.

Lasting has been the most difficult of all the operations from which machinery has attempted to rout hand-work. The work of the laster is to pull the upper tightly over a last, adjust to it the inner sole, insert the counter-shank, and fasten the upper in place. He also applies the outer sole to the upper, but does nothing further. Now, the irregular shape of the upper, requiring looseness at one point, stretching here and pinching there, in order to shape it to the last, makes it exceedingly hard to secure a machine which will do it with any kind of success. Patents, however, were taken out in England in 1842 for a machine intended to perform this work, and these were issued in this country in 1862. Messrs. McKay and Copeland purchased those rights in 1872, and ten years later was introduced what is known as the Copeland laster, a machine for men's work. The shoe in this machine lies in a kind of matrix, under which are leather girth straps attached to iron fingers. The shoe is held stationary while these fingers move up, inward, and down. The toe and heel are lasted by plates which are mounted on a table that oscillates and adapts its motion to the last. But it is not entirely machine-work, as hand-pincers are used to bring the uppers to the last. For women's and misses' shoes the Boston Lasting Machine Company has a different invention. The shoe in that case is lasted on a jack, the upper being drawn over by pincers, and the shoe itself is afterward brought up to the nozzle of the machine, contact with which starts some automatic tack-driving machinery, and the shoes are fastened as shaped with great rapidity. But manufacturers say that there is much to be accomplished yet before the perfection of hand-work is secured and the fingers and pincers can be entirely dispensed with.

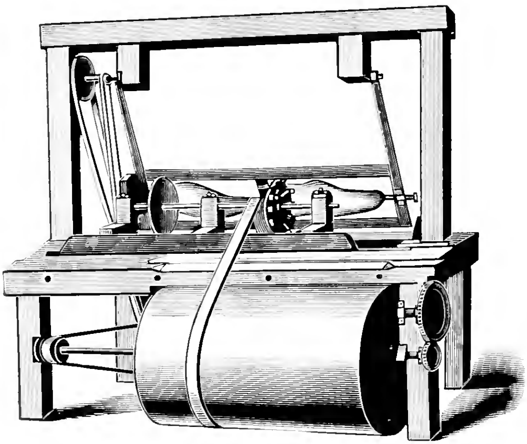

Fig. 13.—First Lathe for Turning Lasts.

The making of these lasts is a considerable industry in itself. Each manufacturer carries a stock of from two thousand to four thousand of them, and they have to be changed with every variation in the style. Originally shoe-lasts were whittled out of rough blocks of wood by hand, but in 1815 Thomas Blanchard, well known in his day as an inventor, devised a lathe for turning them out by a less laborious process. A pattern had first to be made, and then this and a block of wood were fixed on the same axis and made to revolve around a common center in a swinging lathe by a pulley and belt on one end of the axis. The cutting wheel turned on a horizontal axis, and to it were attached a number of irregular cutters which acted like gouges when the wheel was set in motion. This wheel was placed opposite the block, while opposite the pattern was a friction-wheel of the same size. By the combined movements of this axis and a sliding carriage the irregular surface of the pattern caused the axis on which the friction-wheel was to alternately approach and recede, and this motion was in turn communicated to the knife-wheel. The result was that a duplicate of the pattern was produced from the block of wood. The last lathe has been improved since in many ways, but they are all based on the principles introduced by Blanchard.

It is impossible to more than name some of the other machines which have been introduced and which have done much to hasten the manufacture and reduce the cost of foot-wear. The sole-die machine was introduced about 1851, operated first by foot-power and later by steam. The buffing machine, a sanded cylinder for the purpose of giving a velvety finish or "nap" to the bottom of the sole, followed in 1855, and the eyeleting machine in 1864. Other machines of more recent date are the beating-out machine, between the forms of which the sole of the shoe, after the channel groove has been filled with naphtha cement, is subjected to enormous pressure; the trimming machine, whose revolving knives remove the rough edges of the sole; the burnishing machine, and the heeling machinery. It can not but be a source of gratification to Americans that the most of these inventions have had their origin on this side of the ocean, and that those that did not so originate have received their greatest development here. The experiments in England with the sewing and nailing machines had not enough success to warrant any serious claim to the invention. The American shoe-factory is the triumph of American ingenuity. There is no better word than "ingenuity" to describe it. It stands for the discovery of no new principle in mechanics. It represents the utilization of no new force in Nature. But it does contain within it some of the most remarkable adaptations of mechanical principles already known and the most marvelous devices for supplanting the work of the fingers. A modern shoe-factory would make a fitting monument for the Patent Office.

To realize how the introduction of machinery into the tanning

Fig. 14.—A Glimpse of the "City of Shoes."

and shoemaking industries has cheapened the products of the latter, one has only to compare the price of any kind of goods for a series of years. For illustration, take women's Polish grain shoes, men's boots and brogans. These are all cheap goods, and as the prices in the first place would have to be as low as possible great reductions would not be expected. Yet note:

Ladies Polish shoes per pair: 1865, $2.25; 1868, $1.62½; 1870, $1.37½; 1875, $1.12½; 1880, $0.95. Brogans: 1865, $1.75; 1870, $1.50; 1880, $1.30; 1885, $1.20; 1890, $1.05. Men's heavy boots, per dozen pairs, kip and double half soles in order: 1872, $38 and $25; 1880, $26 and $21.50; 1885, $26 and $20; 1890, $21 and $17.

In spite of all competition Massachusetts has retained its early grip upon the shoe industry, and within its factories are to be seen the art at its highest and its results at their best. In 1845, in that State, 45,877 hands made 20,896,312 pairs of boots and shoes, and in 1875 49,608 made 59,762,866 pairs—that is, an increase of less than one tenth in the manual force resulted in an output nearly three times as great. New Hampshire and Maine, however, have considerable interests in the shoe business, and factories are beginning to spring up in the West and the South. Unfortunately, the census figures for the last decade have not been completed; but the following table will tell the story for the thirty years between 1850 and 1880:

	1850.	1860.	1870.*	1880.
Whole number of establishments	11,305	12,487	† 3,151 23,428	† 1,959 17,972
Persons employed	105,254	123,029	91,702 135,889	111,152 133,819
Capital	$12,924,919	$23,358,527	$37,519,019 $48,994,366	$42,994,028 $50,995,144
Wages	$21,622,608	$30,938,920	$42,504,444 $51,972,712	$43,001,438 $54,358,301
Materials used	$23,848,374	$42,729,649	$80,502,718 $93,582,528	$102,442,442 $114,966,575
Value of product	$53,967,408	$91,891,498	$146,704,055 $181,644,090	$166,050,354 $196,920,481
Wages per employé	$205 43	$251 48	$463 50 $382 46	$387 21 $381 07

The increase in the number of establishments between 1860 and 1870 and the decrease between 1870 and 1880 mean no decline in the industry. This change results from the tendency toward consolidation and concentration. Improved machinery has enabled large producers to crowd their smaller competitors out of the business or to force them into combination. The same move-

* Currency.

† The first figures in these columns are special factory statistics. These were collected only in 1870 and 1880.

ment is manifest in other manufacturing industries, like cotton and woolen. The decade following the war was a period of enormous individual expansion, while that succeeding it was one of corporate extension. This fact appears in the marked increase in capital and productive capacity in union with a decrease in the number of separate factories. That the forthcoming census will show further evidences of this change seems certain from the reports that have been published from time to time during the past ten years by those familiar with the progress of the industry. This development, however, has not been at the expense of the operatives, as is shown by the increase in their earnings since the introduction of machinery. The gain has been more than a third, as indicated by the above table. In 1885 the Massachusetts Bureau of Statistics of Labor undertook an investigation of the net profits of the manufacturing industries of the State, and from returns received from 2,344 private boot and shoe manufacturing firms, employing 66,800 operatives, the average yearly earnings of the latter were $385.89; and from 22 corporations, employing 2,731 operatives, the average was $417.06. That would give for the 2,366 concerns annual average earnings of $401.47 for the operatives, considerably in excess of the country at large. The same investigation showed that in the cost of the production of boots and shoes 27·65 per cent was charged to labor and in that of leather 17·07 per cent went to it. This compares with 28·84 in cotton goods, 20·72 in woolen goods, and 27·18 in silk goods. On the side of the manufacturer these returns showed a net profit of 14·06 per cent on the capital invested in the boot and shoe industry against 8·13 per cent in leather, 0·65 in cotton goods, and 5·47 in woolen goods. The American shoe operatives as a body are thrifty and prosperous, and certainly much better paid than their fellow-craftsmen abroad. Skilled operatives in this country earn from $11 to $18 a week, while the same class in England obtain only $5.50 to $8.50, and in Germany $5 to $6.50. Mr. W. L. Terhune, of the Boot and Shoe Recorder, in an account of a trip among the shoe-factories of England, says that the skilled operatives at Northampton told him that they averaged only about $6 a week, so that the annual earnings for the best paid of them scarcely exceeded $300. With the extension, or rather the over-extension, of the business, and the consequent competition, there have come cuts in wages and strikes; but the same leaven of unrest prevails in the other old industries, and there is nothing peculiar about its manifestation, perhaps, except that the operatives and manufacturers in the shoe industry are both better organized than in other branches.

What the next decade has in store for the boot and shoe industry can be only a matter of speculation. At present the machines for the several operations are distinct. Will some genius combine them into a single one? Will it be possible ever to throw into a hopper a side of leather and take out a finished shoe? Such a question appears absurd to-day. But what would our great-grandfathers have thought of the McKay or Goodyear stitchers?

BEGINNINGS IN BOTANY.

By BYRON D. HALSTED, Sc. D.,
PROFESSOR OF BOTANY IN RUTGERS COLLEGE, NEW JERSEY.

MUCH has been said, largely in a theoretical way, concerning the general question of university extension. Various experiments have been made, and by another year definite plans will be matured for the popular presentation of many of the subjects that come within the scope of the extension movement as now understood by those who have had the most to do with the scheme for the education of the masses.

The writer has recently finished a brief course in botany, and, as the method pursued differed in some features from any previously followed, there may be sufficient reason, in this, for presenting an outline of the ground covered and the ways and means employed for bringing the subject to the attention of a popular audience.

The course consisted of six meetings, and the average attendance was fifty. Each session extended over two hours, namely, from four until six in the afternoon of successive Fridays for six weeks in late spring. The first hour of each exercise was devoted to a lecture, and the following were the subjects considered: (1) The Seed, its Origin, Structure, and Uses; (2) the Stem and Root; (3) the Leaf, its Structure and Function; (4) the Flower, its Form and Use; (5) the Fruit—Kinds and Functions; (6) Ferns, Mosses, Algæ, and Fungi.

A full outline of these lectures was furnished each pupil in a sixteen-page syllabus, and the points covered were fully illustrated by means of *papier-maché* models of various sorts of plants, by numerous wall-charts, and, best of all, by a large number of living specimens.

The lecture served as an introduction to the class exercise which it immediately preceded. In this latter each pupil was furnished with a seat at a table and provided with specimens upon which to work. As before stated, the first lecture was upon seeds. This embraced the whole question of germination, and for a portion of the class-hour attention was given to the study of seedling plants, each pupil having specimens of young corn and bean plants for comparison. These two seedlings, because representing the two great types of flowering plants, namely, the exogens and endogens, made it possible to illustrate the leading features of each by contrast. Sketches and descriptions of these were made during the hour by each pupil. Recognizing the fact that seeds come from flowers, and that the time for the course was short, a half-hour was spent in the study of a very simple flower, the spring lily (*Erythronium americanum*). For this purpose a blank was provided, shown in part in Fig. 1, and before the session was through the various parts of a blossom were learned. Similar blanks were given the pupil for home study, and, before leaving, each was handed a box containing five kinds of seeds—namely, corn, bean, flax, clover, and timothy—with directions for sowing in a box or flower-pot for individual home study. In addition to this the first twenty pages of Gray's Revised Lessons were assigned for study. The public library of the city was equipped with a full list of reference-books in botany at the beginning of the course.

Student's Name..................

1. Is the FLOWER—
   Perfect ?
   Complete ?
   Regular ?
   Symmetrical ?
2. Is the CALYX—
   Gamosepalous ?
   Polysepalous ?
   Free ?
   Adherent ?
3. Is the COROLLA—
   Gamopetalous ?
   Polypetalous ?
   Free ?
   Adherent ?
4. How many STAMENS ?
   Free.
   Adherent.
   Anthers.
   Innate.
   Adnate.
   Versatile.

   Filaments.
   Shape.
   Length.
5. How many PISTILS ?
   Free.
   Adherent.
   Stigma.
   Style.
   Ovary.
   Cells.
   Placentation.
   Ovules.
   Number.
   Position.
   Fruit.
   Seed.
6. INFLORESCENCE.
7. LEAVES.
   Arrangement.
   Venation.
   Shape.
   Base.
   Apex.
   Margin.
   Petiole.
   Stipules.
8. STEM.
   Exogenous.
   Endogenous.
9. COMMON NAME.
10. SCIENTIFIC NAME.

Fig. 1.

The second lecture embraced a consideration of the stem and root. The chief differences between these two plant-members were pointed out and illustrated with specimens. Buds, as to their nature, structure, arrangement, etc., were dwelt upon, followed by many illustrations of various kinds of stems, such as tendrils, spines, and numerous forms of subterranean stems, like potato tubers, bulbs, and root-stocks of many plants. Various kinds of roots were shown, particular attention being paid to the functions of these underground portions, followed by an exposition of the way in which the soil constituents are taken up by plants.

The first half of the class exercise of the second day was occupied with a study of the buds of the horse-chestnut, in connection with more advanced specimens of the same species in which the buds have unfolded, and the scales, leaves, and flower-cluster were fully shown. After drawings were made of these, and a study of the corn-stem to illustrate the second type of stem (endogen), the remaining portion of the hour was occupied with work on two flowers of the more simple types gathered from the fields and furnished in abundance. Specimens of these plants, with blanks to fill in connection with the study of them, were taken home by the pupils.

At this session a report of the daily observations of the seedling bean, corn, flax, clover, and grass was submitted, and this work in the home garden continued. Twigs were assigned for study during the coming week, including a potato tuber that had been planted by each pupil the week before.

In the third lecture the subject of leaves was considered as to parts, arrangement, types of framework (venation), simple and compound forms, and various peculiar kinds of leaves were shown, as pitchers, fly-catchers, etc. It was in this lecture that some of the physiological principles of vegetation were brought out, including the taking up of the soil-water, its passage to the leaves, and the manufacture there, under the influence of sunlight, of the various compounds, as sugar, starch, and oil, that may be afterward employed in various ways in the economy of the plant.

The microscopic structure of the pulp of the leaf was shown by diagrams, and an insight was given into the cellular formation of tissues and their combinations into tissue systems. A very large number of kinds of leaves freshly gathered were exhibited to illustrate the many terms concerning foliage used in the classification of plants. In size and shape these varied through all gradations, from the mere scales of the asparagus and conservatory "smilax" to those of the garden rhubarb; and of the compound sorts, from the barberry with a single leaflet to those of the columbine.

The class-hour was devoted to the study of three plants, the flowers of which illustrated as many widely separated types. Thus the wistaria gave large peculiar blossoms of the pulse family, and in this connection a *papier-maché* model of the pea was dissected before the class, thus fully illustrating the several parts, even to the coats and embryo of the forming seeds, by means of a separate model of an enlarged pea-pod.

In the fourth lecture the flower was considered, and, while the parts had been previously learned in class-work with specimens, the functions of the various organs were now explained by means of diagrams and specimens. The many ways in which the pollen of one flower is brought to the pistil of another were illustrated, and the fact that close fertilization is the exception and not the rule emphasized. The pupils were made familiar with the various forms of flower arrangement by seeing the living examples. Perhaps fifty kinds of plants in bloom were shown to illustrate not only inflorescence but the form and union of the several parts of individual flowers.

During the second hour attention was called to the analytical key as an aid in classifying plants, and the class as a whole was instructed by carrying three plants successively through the key to the species. At the same time blanks were filled which made a record of each student's results of inspection. Pupils were now ready to take the simpler plants and classify them at home, which was done to a large extent by some members of the class.

The fifth lecture was a treatment of the general subject of fruits. The subject was illustrated by means of a large list of fruits, freshly gathered from the field, supplemented with several sorts procured at the store. Various seed-vessels may be found in the spring that illustrate fully the methods of opening of the dry fruits for the scattering of seeds, and these were drawn upon at this seemingly unseasonable time for the study of fruits with excellent results. The methods of pressing and mounting plants were practically illustrated at the close of the hour, and a portion of a herbarium placed within reach for inspection.

During the class-hour fresh specimens were supplied, and each pupil worked independently in large part in determining the species. Particular attention was paid to fruits, and the twisting of the cranesbill awns, for example, was seen by all. The sensitiveness of the stamens of the barberry was likewise observed by the class during the hour.

For home work, besides the twenty pages in the text given for each lesson, ten questions were asked in the syllabus, the answers to which were handed in at the next meeting, along with the reports upon "Topics for Study," likewise given in the syllabus. Thus, under Fruits, two of the questions were "(4) In what particular does a strawberry differ from a rose fruit? (6) Of what advantage to a plant that its fruit is a highly colored berry?" Under "Topics for Study" one requirement was to "make drawings of a cross-section of an orange and an apple."

The sixth and last lecture of the course considered the flowerless plants, or those forms of vegetation which are propagated through spores and not by means of seeds.

While upon the ferns, several species in quantity were in the hands of the members of the class, and the method for classifying them gone through with while the descriptive terms necessary for this were being considered. Plates covered with fresh mosses, some sterile and others in fruit, were passed around, while the manner of spore-formation was illustrated by a large *papier-maché* model of the moss capsule, that was dissected before the class. Various groups of fungi were considered, some of the larger forms shown, as the toad-stools, shelf fungi, and the like, and several rusts were also exhibited. The lecture and the course closed with a consideration of the various groups of sea-weeds, specimens of which were handed around the class. The leading books upon the several families of cryptogams were shown, especially those illustrating the subject by means of large plates.

It was announced in the syllabus that the examination for certificates would be held in the following autumn, and at the close of the last lecture a conference was held with the candidates, about twenty-five, and a short preliminary examination given them upon the matter contained in the syllabus. This portion of the class was instructed to make a careful study of the whole of Gray's Revised Lessons, and encouraged to collect specimens, study and classify them, and make a herbarium of at least fifty species to in part represent the work done in the field.

Thus in six exercises pupils were more than started in the study of plants, and there is no question that a groundwork was laid for an acquaintance with botany that should be one of constantly growing interest as the years succeed each other.

MICHAEL SERVETUS: REFORMER, PHYSIOLOGIST, AND MARTYR.

By CHARLES McRAE.

THE sixteenth century produced an unusually large number of famous biologists. To it belonged Andreas Vesalius, the incomparable anatomist, and his teachers, Sylvius and Winter of Andernach; Columbus of Cremona, to whom the discovery of the pulmonary circulation of the blood was for a century and a half ascribed; and Fallopius, Eustachius, Arantius, Fabricius of Aquapendente, and Cæsalpinus—men whose names have become familiar to every student of anatomy. Foremost, perhaps, among these illustrious workers stands the name of Michael Servetus, the physiologist and liberal thinker, who was burned to death as a heretic at Geneva in 1553, and whose life and tragic end have ever since excited the interest and sympathy of mankind.

Michael Servetus was born in Aragon or in Navarre about the year 1509. At an early age he entered the University of Saragossa, from which, in 1528, he was sent as a law student to the University of Toulouse. Here he may have read some of Luther's writings, for several of the latter were translated into Spanish soon after their publication. But whether he saw them or not, after staying two or three years at Toulouse he acquired certain views which were antagonistic to some of the generally received dogmas of the Church, and which influenced the whole of his subsequent life.

Quitting the university, he went—in what position it is unknown—with a Franciscan friar named Quintana, who was confessor to the Emperor Charles V, to Bologna, to the coronation of that monarch. And here, in Italy, it is supposed that he met with opinions which strengthened his desire for liberty of thought, for about this time he thus expresses himself: "For my own part I neither agree nor disagree in every particular with either Catholic or Reformer. Both of them seem to me to have something of truth and something of error in their views; and, while each sees the other's shortcomings, neither sees his own. God, in his goodness, give us all to understand our errors, and incline us to put them away." . . .

Leaving Bologna, the emperor with his suite proceeded to Germany to hold the Diet of Augsburg. And here Servetus probably saw and spoke to some of the leading Reformers.

Soon after this, however, he quitted the service of Quintana, and we find him seeking the friendship of certain of the Reformers, Œcolampadius and Bucer. He must have had the power of winning friends, for Bucer, in a letter, speaks of him as his dear son, "*filius meus dilectus*."

In 1531 Servetus published at Hagenau his first book, De Trinitatis Erroribus. This production of a young man only twenty-one or twenty-two years of age, crude as it was, excited remark from Luther and Melanchthon. In the Table-Talk of 1532 Luther refers to it as "a fearfully wicked book which had lately come out against the doctrine of the Holy Trinity. Visionaries like the writer do not seem to fancy that other folks as well as they may have had temptations on this subject. But the sting did not hold; I set the Word of God and the Holy Ghost against my thoughts and got free."

Melanchthon confesses he has read Servetus much. "I see him indeed sufficiently sharp and subtle in disputation, but I do not give him credit for much depth. He is possessed, as it seems to me, of confused imaginations, and his thoughts are not well matured on the subjects he discusses."

Œcolampadius wrote: "Our senate have forbidden the Spaniard's book to be sold here. They have asked my opinion of its merits, and I have said that as the writer does not acknowledge the co-eternity of the Son, I can in no wise approve of it as a whole, although it contains much else that is good."

Servetus now followed this with Two Dialogues on the Trinity, explanatory and additional to the former work. Thus he published two books against the principal dogma of the Church in less than two years, without hesitating to put his name on the title-page of both. He was very young, extremely zealous for his new opinion, and perhaps unacquainted with the principles of the Reformers. He may have thought that if they wrote freely about the doctrine of Transubstantiation, why should he not inquire into the truth of the doctrine of the Trinity. But the reception afforded to his two works was of such a kind as to convince him that he had committed an imprudent act in allowing his name to appear as the author, and he accordingly changed his name and retired to Lyons. The name he now assumed, and by which he was always afterward known, was Michael Villeneuve, or Villanovanus, after the town of Villanueva, in Aragon, from which he probably came.

At Lyons he found work as a corrector for the press, at the publishing firm of the Brothers Trechsel, and he edited the Geography of Ptolemy. The description of Palestine which this book contained, although really an extract and not an original statement by Servetus, was quoted against him eighteen years afterward when he was tried for his life at Geneva. It concluded with these words: "Know, however, most worthy reader, that it is mere boasting and untruth when so much of excellence is ascribed to this land; the experience of merchants and others, travelers who have visited it, proving it to be inhospitable, barren, and destitute of all charm. Wherefore you may say that the land was *promised*, indeed, but is of *little promise* when spoken of in every-day terms."

The latter part of the following description of the Germans, which is given in this book, looks like an expression of Servetus's own opinion: "Hungary is commonly said to produce oxen, Bavaria swine, Franconia onions, turnips, and licorice, Swabia harlots, Bohemia heretics, Switzerland butchers, Westphalia cheats, and the whole country gluttons and drunkards. The Germans, however, are a religious people; not easily turned from opinions they have once espoused, and not readily persuaded to concord in matters of schism, every one valiantly and obstinately defending the heresy he has himself adopted."

While thus working at Lyons, Servetus formed the acquaintance of Doctor Campeggius, to whose influence it was perhaps due that he decided to take up the study of medicine. To carry out this determination he proceeded to Paris, and entered as a student at the university under Johannes Guinterus (Winter of Andernach) and Sylvius. Here he had as a fellow-student Andreas Vesalius, the famous anatomist, to whom, as well as to Servetus, their teacher Winter makes a laudatory reference some time afterward. Writing in the preface to his Anatomical Institutions, published in 1539, Winter informs his readers that he "had been effectually aided in the preparation of the work, first by Andreas Vesalius, a young man, by Hercules! singularly proficient in anatomy; and after him by Michael Villanovanus, distinguished by his literary acquirements of every kind, and scarcely second to any in his knowledge of the teaching of Galen."

After taking his degree, Servetus lectured in Paris on geometry and astrology. The lectures on the latter subject involved him in a dispute with the university; and in March, 1538, we find him defending by counsel a suit that was brought against him by the medical faculty on account of these lectures. In 1537 he wrote a little book, Syruporum Universa ratio, the most popular, perhaps, of all his writings, containing six lectures on digestion, with one chapter—the fifth—devoted to the composition and use of sirups, or *tisanes*.

In June, 1538, he was at the University of Louvain studying theology and Hebrew; and in a letter to his father written from this place, he explains that he has left Paris, owing to the death of his master, but hopes to return soon. After practicing as a doctor for a short time at Charlieu, he continued his studies for part of 1540 at the University of Montpellier, where unusual facilities were at that time afforded to medical students.

At Paris, some years before, Servetus had made the acquaintance of Pierre Paumier, a man of learned tastes, who was now Archbishop of Vienne, in Dauphiny. At his invitation the Spaniard took up his residence at Vienne, and there appears to have lived in quiet seclusion from 1541 to 1553. His professional work was not too heavy to allow of his taking up literary pursuits also. He brought out a new edition of Ptolemy's Geography, and he annotated the Latin Bible of Pagnini. In his preface to the latter work he intimates what he considers to be the proper method of interpreting the prophetical books. He says that people who are ignorant of the affairs and customs of the Hebrews easily think the historical and literal sense of no importance; and in consequence of this they ridiculously follow a mystical interpretation everywhere. "Wherefore," he adds, "I would desire you again and again, Christian reader, to get the knowledge of the Hebrew in the first place, and, after that, diligently to apply yourself to the study of Jewish history, before you enter upon the reading of the prophets."

One of the gravest charges brought against Servetus by Calvin was that by such a method of interpretation "this impostor has dared to give such a wrong turn to the passages (contained in the fifty-third chapter of Isaiah) as to interpret them of Cyrus. So that whatever the prophet has with great perspicuity, and with the utmost force of expression, discoursed, this perfidious villain has blotted out (*delevit hic perfidus nebulo*)."

Here it may be remarked that while no one would pretend that Servetus was a biblical critic and expositor, yet his method of looking first for the historical and literal meaning is the method of the modern school of scriptural exegesis.

The book which immediately brought about the imprisonment and death of Servetus was called Christianismi Restitutio—the Restoration of Christianity. It contained, besides a series of chapters setting forth the various theological tenets of the author, thirty letters addressed to Calvin. The views of the writer, although fantastical, and in many instances unintelligible, often exhibit a broad and tolerant spirit, and always breathe intense earnestness. He appears to have felt himself impelled to propagate his opinions on these theological matters, and to have come to regard this as his mission in life, which must be fulfilled at any risk. So much, at least, is clear from the invocation to Christ, with which he closes his introduction. "Thou hast taught us that the light is not to be hidden, so woe to me unless I evangelize." * He seems even to have thought that he had his vocation shadowed out to him in his name. The angel Michael led the embattled hosts of heaven to war against the dragon; and he, Michael Servetus, had been chosen to lead the angels on earth against Antichrist!

This book is now one of the rarest in the world. Two copies only are known to be extant—one at Paris and another at Vienna. A copy of the latter, printed in 1790, is in the British Museum.

In this work, while writing on the Trinity (Book V), Servetus introduces certain physiological statements in order to illustrate some of his theological speculations. The passage, although lost to the world for nearly a century and a half, has long ago become famous. It was first brought to light in Wotton's Reflections upon Ancient and Modern Learning, published in London in 1694. It proves that the knowledge which Servetus possessed of the way by which the blood passed from the right to the left side of the heart was in advance of his time, and a step beyond that reached by Galen. The latter had taught that the blood, for the most part, passed through the septum, from one side of the heart to the other. Servetus wrote: "This communication" (i. e., from the right ventricle of the heart to the left) "does not take place through the septum, partition, or midwall of the heart, as commonly believed, but by another admirable contrivance, the blood being transmitted from the pulmonary artery to the pulmonary vein, by a lengthened passage through the lungs, in the course of which it is elaborated and becomes of a crimson color. Mingled with the inspired air in this passage, and freed from fuliginous

* "Lucernam non esse abscondendam, tu nos docuisti, ut væ mihi sit nisi evangelizem." Christ. Restit., p. 2.

vapors by the act of expiration, the mixture being now complete in every respect, and the blood become fit dwelling-place of the vital spirit, it is finally attracted by the diastole, and reaches the left ventricle of the heart." He then goes on to give as proofs of the accuracy of his statements (1) the various conjunctions and communications of the pulmonary artery and pulmonary vein in the lungs, and (2) the great size of the pulmonary artery, and the great quantity of blood passing through it; both being much larger than would be required for the mere nutrition of the lungs. He concludes that the septum, seeing that it is without vessels and special properties, is not fitted to permit the communication in question, "although," he adds, "it may be that some transudation takes place through it." * This unfortunate qualification of what he has so distinctly affirmed just before—namely, that the communication does *not* take place through the septum—is not very intelligible; for if he believed the blood to soak through the septum, his theory differs but little from that of Galen, and yet Servetus calls attention to the fact that what he is declaring was unknown to Galen.†

Prof. Huxley ‡ points out that Servetus quotes neither observation nor experiment in favor of the imperviousness of the septum. But neither does Realdus Columbus,# who correctly described the lesser circulation in 1559, and to whom the credit of the discovery was very early ascribed.‖ It is to be remembered that the work in which Servetus introduces his discovery is not a treatise on physiology, and that the whole passage being brought in by way of illustration is not fully treated.

It is clear, however, that Servetus held (1) that the blood in a great stream passes from the right ventricle of the heart to the lungs; (2) that in the lungs, and not in the left ventricle, it is purified; and (3) that from the lungs it passes by the pulmonary vein to the left ventricle of the heart and thence into the arteries.

From these statements of fact Servetus quickly passes to metaphysical speculations. He has before said: "There are three sorts of spirits in the human body—namely, natural, vital, and animal—which are not in reality three, but two distinct spirits only; the arteries communicating by *anastomoses*, the vital spirit to the veins, in which it is called natural. The first spirit then is the blood, whose seat is in the liver, and in the veins of the body; the second is the vital spirit, whose seat is the heart and arteries; the

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* "Licet aliquid resudare possit." Christ. Restit., p. 171.

† Christ. Restit., p. 171.

‡ Fortnightly Review, February, 1878.

\# De Re Anatomica Realdi Columbi Cremonensis, 1559, p. 177.

‖ Opera Chirurgica Ambrosii Paræi, 1594, p. 116.

third is the animal spirit, whose seat is in the brain and nerves." Now, he goes on to suppose that the blood, having received in its passage through the lungs the breath of life, is sent by the left ventricle into the arteries. The purest part ascends to the base of the brain, where it is more refined and changed from the vital to the animal spirit, and acts upon the mass of the brain, which is incapable of reasoning without its stimulus. From this, and much more which is unintelligible, it appears plain that Servetus had read the schoolmen, and was imbued with their methods of reasoning.

To get published a book filled, as the Christianismi Restitutio was, with theological opinions repugnant alike to Catholics and Reformers, was no easy task. And in effecting his purpose Servetus exercised great caution and ingenuity. At Vienne, where he had lived for twelve years, was a publisher named Arnoullet, whom, with the printer Geroult, Servetus took into his confidence. He engaged not only to pay the whole expenses, but also to add a gratuity of a hundred crowns. It was arranged that the printing should not be carried on at the ordinary place of business, but that a small house at some distance should be used for the purpose. The printing was commenced on St. Michael's day, and in three or four months one thousand copies of the book were ready.

No name appeared on the title-page, but at the end of the book immediately over the date the initials "M. S. V." were placed, and at page 199, at the commencement of the dialogue between Michael and Petrus, the latter is made to say: "Here he is; Servetus is here, of whom I was speaking." The reference made in the preface to former works on the same subject, and the introduction of Michael and Peter as interlocutors, just as had been done in the Dialogue on the Trinity twenty years before, rendered it easy to establish that Michael Servetus and Michael Villeneuve were one and the same man.

The whole stock of books, when ready, was made up into bales of one hundred each, and sent away, the greater part to Lyons, to the care of a type-founder named Pierre Merrin, who believed that the packets contained nothing but blank paper. It was probably intended to forward them, as soon as opportunity offered, to Genoa and Venice.

Meanwhile, unknown to Servetus, a copy of the work, and a letter giving particulars of the printing of it, were dispatched to Calvin at Geneva, probably by some one at Lyons, who had friends at Vienne, and who was in the confidence of both Servetus and Calvin. Armed with this evidence against the Spaniard, Calvin caused a letter to be written to Vienne by a young man named William Trie, denouncing Servetus, and inclosing the first few sheets of the Christianismi Restitutio. By a subsequent mail he sent by the same man about twenty letters, which he had received from time to time from Servetus. On this the latter was arrested, and conveyed to prison on the pretense of being required to see some sick prisoner. He was immediately examined closely as to his early history and the meaning of some of his writings. Taken by surprise, as he was, he appears to have prevaricated, and tried to hide his identity with the author of De Trinitatis Erroribus, by pretending that in his letters with Calvin he had personated Servetus merely for the purpose of discussion. Facts looked very black against him, but he probably had very powerful friends, and it may have been with the connivance of some of them that two days afterward he made his escape from prison. The whole plot was soon ferreted out by Matthew Ory, the Inquisitor; the books were seized, and Servetus was condemned "in a pecuniary mulct of a thousand livres, to be paid to the King of Dauphiny"; and the sentence went on, "as soon as he shall be taken he shall be drawn in a dung-cart, with his books, on the market-day and hour, from the gate of the Royal Palace, through the streets and accustomed places, to the common hall of the present city, and from thence to the place called Charneve, and there he shall be burnt alive, with a slow fire, until his body shall be reduced to ashes. In the mean time the present sentence shall be executed in effigy, with which the said books shall be burnt."

This sentence was duly carried out on June 17, 1553, the effigy and five bales of books being burned to ashes.

Of such action as Calvin's in thus betraying what had been communicated to him in the confidence of a letter, into the hands of a professed enemy of both, Erasmus expresses himself as follows: "You are not ignorant how abhorrent, I do not say from virtue, but entirely from all humanity, it is to betray the secrets of friendship; forasmuch as we detest even those who, after a breach of friendship, shall divulge what was said in confidence before; nor can those of a generous disposition suffer themselves to betray that which they know, from the confidence of ancient friendship, will expose one to the resentment of his greatest enemies."

Having escaped from Vienne, Servetus probably remained in hiding first at Lyons. But the discovery of the whole matter, and his subsequent condemnation, made it imperative that he should get out of France. Many Spaniards were settled at Naples, and thither he now seems to have determined to push his way. For some reason or other, probably because he expected more leniency from Reformers than from Catholics, he preferred to go through Switzerland rather than Piedmont. He reached Geneva, and lodged at the Rose Inn, intending to go by boat to Lausanne on his way to Zurich. Calvin, however, learned that he was in the town, and he immediately informed the first syndic, and caused him to be apprehended; and here he was kept while proceedings were being taken against him, from August 14th to October 27th.

The people of Geneva, in the year 1553, were, and had been for several years, divided into two hostile parties, struggling desperately with each other for the supremacy. The austerity and tyranny of Calvin had aroused against him many opponents, and it seemed now as if these were on the point of attaining the ends for which they had been so long striving. Calvin's earliest attempts at ruling the Genevese had soon met with failure. He had first settled in Geneva in 1536, but so unpopular had he become in two years that he and his colleague, Farel, were formally banished from the city. Passing from Basle to Strasburg, he had taken up his residence in the latter city as Professor of Theology. But after two years, in response to a deputation which came and besought his return to Geneva, he consented to go back, and in September, 1541, he took up his old position under greater advantages than before. He then laid before the Council the draft of his ordinances respecting church discipline, and these were at once accepted. A consistory was formed, composed for the most part of clergymen, with the addition of a few laymen, "to watch over the support of the pure doctrine and of morals." The tribunal called everybody, without exception, to account for his slightest words or actions, and referred cases, where ecclesiastical censure was not sufficient, to the Council. Thus Calvin had made himself director of the conduct as well as of the opinion of the Genevese. His spirit governed exclusively in the Council as in the Consistory, and no one could hope to succeed who set himself in opposition to Calvin.

Twelve years of such bondage, however, had not been borne by the Genevese without indication of discontent and dissatisfaction. The Council declared that clergymen could no longer be admitted to its meetings, although they had not been previously excluded; men who were under the consistorial ban for some infringement of discipline were chosen as councilors, and even open hostility was shown to Calvin, who wrote: "The accumulated rancor of their hearts breaks out from time to time; so that when I show myself in the street, the curs are hounded on me."

To the great misfortune of Servetus it was at such a time as this that he arrived in Geneva. His case became the subject of dispute over which the two factions fought one of their bitterest struggles; and although Calvin had declared some years before that if the Spaniard ever came to that city he should not escape with his life,* yet probably the relentless Reformer was now bent on his destruction quite as much by a desire to defeat the opposite party as by the personal hatred he had for Servetus.

The nominal prosecutor of Servetus was a creature of Calvin's—a certain Nicolas de la Fontaine—who, in accordance with the law, had not only to bind himself over to continue the suit to a conclusion, but also to go to prison with the accused man, and, in compliance with the requirements of the *lex talionis*, to engage, in case his charges were not made good, to undergo the penalty that would have fallen on the accused had they been established.

Thirty-eight articles of impeachment were advanced against Servetus. One of these was that he had defamed Mr. Calvin and the doctrine that he preached. To this Servetus replied that he had had abusive language from Calvin, and that he had only answered in the same terms. La Fontaine produced Ptolemy's Geography, the annotated Bible, the Christianismi Restitutio, and certain MS. letters, and Servetus admitted that he was the author of all. It having been considered now that sufficient evidence had been furnished to warrant prosecution by the attorney-general, the court relieved La Fontaine of all charge, damage, and interest in the matter, and Servetus was committed for trial.

At the trial, passages from Ptolemy's Geography as to the character of Palestine were adduced as proofs of the heretical opinions of the prisoner, and when the latter added that the notes contained nothing harmful, or that was not true, Calvin himself warmly interposed. And writing afterward about the event, he says: "When Servetus stood so plainly convicted of this his impiety he had nothing to allege in his vindication. The filthy cur, laying aside all shame, asserted in one word that there was no harm in it."

The annotations of the Pagnini Bible were produced again, and Servetus was examined as to his method of interpreting prophetical passages, and then the meaning of certain extracts from the Christianismi Restitutio was inquired into, and a letter from Servetus, written about six years before to Abel Pepin, a preacher at Geneva, was put in. It contained two remarkable passages: "It is perhaps far from agreeable to you that I should concern myself with Michael's war in the Apocalypse, or that I should desire to bring you into the strife. But do so much as consider that passage narrowly, and you will soon perceive who the men were to be who would engage in that quarrel, namely, such as were resolved to expose their lives to death for the blood and the testimony of Jesus Christ. . . . That I must die for the cause I have espoused I certainly know; but I am not at all cast down

* In a letter from Calvin to Farel, dated Ides of February, 1546. Now in Paris Library.

on that account, since by that I shall be a disciple made like to his master."

Some days afterward Calvin came into court attended by all the ministers of Geneva, and undertook to prove that the teaching of the early fathers of the Church was opposed to that of Servetus. After Calvin and the prisoner had had a long dispute as to the meaning of the word *persona*, the court adjourned, but before doing so the judges gave permission for Servetus to be provided, at his own cost, with such books as he needed, which could be obtained in Geneva or Lyons. Some paper and ink, with which the prisoner was now for the first time furnished, enabled him to send in a petition on the following day. In this he pointed out that the prosecution, as a criminal, of a man on account of the views he held on doctrine was contrary to the Scriptures and to the ancient Church; and he begged that, as he was a foreigner, wholly unacquainted with the customs of the country, and of how he should proceed, he might be allowed an advocate. But to this very reasonable request, although subsequently repeated more than once, the judges did not accede.

The Syndics and Council of Geneva now addressed a letter to the authorities of Vienne, asking that the documents connected with the trial of Michael Villeneuve might be sent to them; and, three days after, they received a letter saying that these documents could not be forwarded, but that, if the prisoner were delivered over to them, the sentence already passed on him would be carried into effect. Servetus was hereupon asked if he preferred remaining in the hands of the Council or to be sent back to Vienne. Knowing full well that a cruel death most certainly awaited him in France, and hoping that no such punishment was in store for him here, he fell on his knees and besought the Council to do what they would with him, but in no case to send him back to Vienne.

The trial was accordingly continued.

Meanwhile, Servetus lay in one of the foul cells set apart for criminals of the lowest class, and we find him writing in a petition, dated September 15th: "Calvin is resolved that I should rot in a prison to please him. I am eaten up with lice. My hose are worn to pieces and I have no change, nor another doublet, and only one shirt, and that in tatters."

Another petition, dated a week later, ends with the words: "Wherefore, my lords, I desire that my false accuser should be punished *pœna talionis*, and confined to prison as I am, till he or I be condemned to death or to some other punishment. I am willing to die if he is not convicted both of this and other things which I shall lay to his charge. I beg of you, my lords, to do me justice. Justice, my lords, justice!"

Finally, on October 10th, comes his last appeal: "It is now three weeks since I desired to have a hearing, but could not obtain it. I beseech you, for the love of Jesus Christ, not to deny me what you would not deny a Turk, when I beg you to do me justice. I have several things to tell you that are very important and necessary. As to what you may have ordered to be done for me in the way of cleanliness, I have to inform you that nothing has been done, and that I am in a more miserable condition than ever. In addition to which, I suffer terribly from the cold and from colic, and my rupture, which causes me miseries of other kinds that I should feel shame in writing about more particularly. It is very cruel that I am neither allowed to speak nor to have my pressing wants supplied. For the love of God, my lords, either in pity or in duty, give some orders in my behalf."

During this time a letter was sent by the Council of Geneva to the different Swiss churches, asking for an expression of opinion on the case of Servetus. The answers came back in due course, and the Spaniard was declared to be an intolerable monster of impiety, and to have revived the wicked errors "with which Satan did formerly disturb the Church." The Church of Zurich was more vehement than the rest in exhorting the magistrates to deal severely with him.

On the morning of October 27th, Servetus was summoned "to learn the pleasure of my lords the Councilors and Justices of Geneva," and before the porch of the Hôtel de Ville he heard his condemnation: "To be burned alive, along with thy books, printed as well as written with thy hand, until thy body be reduced to ashes. So shall thy days end, and thou be made an example to others who would do as thou hast done."

The sentence was immediately carried into execution. In a few hours Calvin's most subtle disputant had forever ceased to trouble him, and the world was the poorer by one loving, faithful spirit.—*The Gentleman's Magazine.*

The two main things required in anthropological study, said the Rev. Lorimer Fison, sectional president in the Australasian Association, are a patient continuance in collecting facts and the faculty of seeing in them what is seen by the natives themselves. But the natural tendency to form a theory as soon as a fact is seized, and looking at facts from the mental point of view of civilized man, may lead investigators into fatal mistakes. The best way to gain information is to live with the natives, learn their language, and get their confidence, or get information from the men living among them. References to aborigines, their manners and customs, in books might be collected and classified by many readers (as has been done in Spencer's Descriptive Sociology), and thus facilitate investigation. The speaker dwelt on the magnificent and all but untrodden field afforded by British New Guinea and its outlying groups of islands.

THE ROYAL SOCIETY; OR, SCIENTIFIC VISIONARIES OF THE SEVENTEENTH CENTURY.

By MARY DAVIES STEELE.

DURING the English Commonwealth period two little companies of natural philosophers were in the habit of meeting for study and experiments—one in London, and the other at the lodgings of Dr. Wilkins, warden of Wadham College, Oxford. At a later day these small clubs of *virtuosi*, as the scientists of that age were called, were united, and the society held all its sessions in London, at a tavern or private house; and when finally it attained such dimensions that a large room was necessary, it established itself in the parlor of Gresham College. It was originally called the Philosophic Assembly; but when, soon after the restoration of Charles II, Evelyn, in his dedicatory epistle, prefixed to Naudé's Treatise on Libraries, spoke of the Philosophic Assembly as the Royal Society, the name was immediately adopted by the members, with a vote of thanks to him for suggesting it. Charles was gratified, and declared himself their founder, giving them, as Evelyn records, August 21, 1662, "the armes of England, to be borne in a canton in our armes; and sent us a mace of silver gilt of the same fashion and bigness as those carried before his Majesty, to be borne before our president on meeting days." Evelyn, besides writing several books, at the request of the society, procured for it from the Howard family the noble Arundelian Library, adding, on one of his birthdays, his table of the lungs, liver, veins, and arteries; the first chart of the kind that was ever made. A rare print, designed by Evelyn, probably as a frontispiece to Spratt's History of the Royal Society, and beautifully engraved by Hollar, represents Lord Bacon as the founder of the society; for, as Disraeli says, he "planned the ideal institution in his philosophical romance of the New Atlantis." The picture contains fine portraits of Charles II, patron of the society; Lord Brouncker, its first president, and Lord Bacon, its founder, inscribed *Artium instaurator*. The library, statutes, journals, and mace of the Royal Society, and numerous philosophical instruments are represented in the engraving.

One peculiarity of the association was that men of all nations, religions, and professions were admitted to membership; for, as their historian, Bishop Spratt, said, they did not wish "to lay the foundations of an English, Scotch, Irish, Popish, or Protestant philosophy, but a philosophy of mankind." When the Society for Promoting Christian Knowledge desired to hold its meetings in the Royal Society's rooms, Sir Isaac Newton made the following protest against their admission: "It is a fundamental rule of the society not to meddle with religion; and the reason is that we may give no occasion to religious bodies to meddle with us"; nor did the Fellows wish to "dissatisfy those of other religious bodies" who did not share the views of the Christian Knowledge Association. In the early days of the Philosophic Club, when only a few intimate friends belonged to it, Robert Boyle, on account of its smallness and lack of influence, often sportively called it the Invisible College—a name which, when this learned junto had become large and important, was recalled with terror by the enemies of the association, whether Aristotelians or religious bigots, who alike considered "the new experimental philosophy subversive of the Christian faith." The newly invented telescope and microscope were regarded by others besides ignorant fanatics with hatred and dread, as "atheistical inventions which perverted our sight, and made everything appear in a new and false light."

The opponents of the Royal Society asserted that the principal object that its supporters had in view was the extinction of universities, which were the strongholds of scholasticism and theology. Yet this association was one of the chief interests in the lives of many of the most devout and scholarly men of the seventeenth century. "Our holy religion" held the first place in their hearts, though they considered the "new philosophy" second in importance to Christianity. The imaginations and plans of the society were magnificent, but they were never carried out. The Fellows were fond of talking of their "universal correspondence," which, in the near future, would keep their ten secretaries—who, however, were never elected, though the constitution provided for them—hard at work; and they loved to throw an air of secrecy over their deliberations. These harmless vaunts and concealments added to the panic which the *virtuosi* excited in people who were ever dreading the establishment, openly or by the treachery of the Jesuits, of popery and arbitrary power, and led to the most unfounded suspicions and accusations.

One of the most injurious things said against the society was that its members were of the school of the Italian Campanella, who, it was *claimed*, wished to identify church and state throughout the world, and bring all nations under the power of a single tyrannical ruler, and to that end would divert men from theology and politics by occupying them with experimental philosophy. Campanella's universal king, as soon as by trickery or by some unaccountable and unexplained means he had firmly seated himself on his throne, would, it was asserted, carry out the dearest object of the philosopher, and substitute everywhere the ancient pagan philosophic for the modern Christian sects. Probably

Campanella and the more intelligent F. R. S. would alike, instead of advocating despotism in any shape, have asserted that if men were allowed to experiment, analyze, dissect, and philosophize "with the utmost freedom, the despotism of religion and politics would dissolve away in the weakness of its quiescent state." The truth is, the scholastics who opposed the experimental philosophy considered novelty of speculation, without regard to character or tendency, as heresy and treason. Perhaps Evelyn inadvertently raised this specter of Campanellaism. Naudé—whose book on libraries he translated for the Royal Society—was not only a skeptic and an advocate of absolute monarchy, but he was a warm friend and defender of Campanella, whose religious and political views are not very clearly defined.

Spratt, in his History of the Royal Society, eulogized Charles II for his interest in science; but Stubbes, his opponent, perhaps not wholly unmindful of the ignorant popular prejudice against Campanella, retorted that the natural philosophers were likely to *demoralize* the king (was anybody capable of that!), for "never prince acquired the name of great and good by any knickknacks, but by actions of political wisdom, courage, and justice."

It seems strange, when reading the literary and scientific history of the seventeenth century, to find Sir William Temple among the scoffers at the *virtuosi.* Personal dislike of some of the founders of the Royal Society was, no doubt, the reason *in part* of his opposition to experimentalists. He fancied the Fellows a "set of Sir Nicholas Gimcracks," and, with the wise men of Gotham probably in his thoughts, "contemptuously called them, from the place of their first meeting, 'men of Gresham.'"

In a letter to Cowley, urging the poet to write his poem in praise of the society—an ode described by Macaulay as "weighty in thought and resplendent in wit"—Evelyn indignantly exclaims: "There be those who aske, What have the Royal Society done? Where their colledge? I neede not instruct you how to answer or confound these persons, who are able to make even these informe Blocks and Stones daunce into order, and charme them into better sense. Or if their insolence presse, you are capable to shew how they [the F. R. S.] have layd solid foundations to perfect all noble Arts, and reforme all imperfect sciences. It requires an History to recite onely the Arts, the Inventions, and Phaenomena already absolved, improved or opened. In a word, our Registers have outdone Pliny, Porta, and Alexis, and all the Experimentalists, nay, the great Verulam himselfe, and have made a nobler and more faithfull Collection of real seacrets, usefull and instructive than has hitherto been shewn. Sir, we have a Library, a Repository, and an assembly of as worthy and greate Persons as the World has any; and yet we are sometimes the subject of Satyr and the songs of Drunkards. We have a king to our founder and yet want a Macaenas; and above all a Spirit like yours to raise up Benefactors and to compell them to thinke the Designe of the Royall Society as worthy of their reguards and as capable to embalme their names, as the most heroic enterprise, or anything Antiquity has celebrated; and I am even amaz'd at the wretchednesse of this Age that acknowledges it no more. But the Devil, who was ever an enemy to Truth and to such as discover his praestigious effects, will never suffer the promotion of a designe so destructive to his dominion, which is to fill the world with imposture and keep it in Ignorance, without the utmost of his malice and contradiction. But you have numbers and charms that can binde even these spirits of darkenesse, and render their instruments obsequious; and we know you have a divine Hyme for us; the luster of the Royall Society calls for an Ode from the best of Poets upon the noblest Argument. To conclude, you have a field to celebrate the Greate and the Good, who either do or should favour the most august and worthy designe that ever was set on foot in the world; and those who are our real Patrons and Friends you can eternize, those who are not you can conciliate and inspire to do gallant things."

Evelyn's indignant defense of his beloved association is not surprising when we read the abuse the F. R. S. received from some of the most talented writers of the seventeenth century. The witty Dr. South said that the members of the Royal Society "could admire nothing but fleas, lice, and themselves." Hobbes, the philosopher of Malmesbury, considered them so many laborers, apothecaries, gardeners, and mechanics, who "might now all put in for and get the prize." Cross, Vicar of Chew, wrote ribald pamphlets and ballads, which he got sung about the streets, against the new philosophy. Stubbes, a man of perverted genius, accused the F. R. S. of atheism and treason, and they greatly feared his formidable series of attacks. Dr. King burlesqued their published volumes of Transactions, and ridiculed alike their grammar, style, and the inventions and discoveries they described. Wotton, who was a less sensitive F. R. S. than Evelyn, treats King, in his Reflections upon Ancient and Modern Learning, with "great good humor." He says: "A man is got but a very little way [in philosophy] that is concerned as often as such a merry gentleman as Dr. King shall think fit to make himself sport." Sir John Hill published a quarto volume of satire in the form in which the Transactions of the society were issued, and other books against the Fellows. But he did them good, for his parodies and ridicule taught them to be more cautious in the selection of papers for their printed reports.

In his preface to his Sylva the usually amiable Evelyn scolds at a rate we should have thought impossible to him, at "the ignorant and comical buffoons who, with an insolence suitable to their understanding, are still [as he repeats] crying out, 'What have the society done?'" And he prophesies that the society "will survive the triumphs of the proudest conquerors; since when all their pomp and noise is ended, they [the F. R. S.] are those little things in black, whom now in scorn they term philosophers and fops, to whom they must be obliged for making their names outlast the pyramids, whose founders are as unknown as the heads of the Nile."

Unfortunately, though Evelyn's claim for the society was substantially correct, the *virtuosi* laid themselves open to ridicule by their many trifling, useless, and ludicrous questions, researches, and experiments, and much of their labor was wasted, and its results are now forgotten. The great Mr. Boyle is represented as mortified by the absurd investigations of trivial subjects in which some of his colleagues engaged, and as on one occasion tendering to a friend, with blushing and confusion at the simplicity of the society, their paper "giving instructions for inquiries." That "pleasant rascal," the witty Charles II, whom Evelyn could hardly have numbered among the scorners whom he described as "magnificent fops, whose talents reach but to the adjusting of their perukes," set the example of making fun of the Fellows on the very day that he constituted them a society. He dined with them on this occasion, as he did afterward; when he was not present they feasted on venison sent them by his Majesty. Toward the close of this first meeting, after expressing his satisfaction at being the only King of England who had founded a scientific society, he added, with that "peculiar gravity of countenance" which he assumed when preparing to mystify or hoax his companions with some witty but apparently grave and sincere remark or question, that he had no doubt the learned men before him could solve a problem that had long puzzled him. This was the question: Suppose two pails of water of the same weight were placed in two different but equally balanced scales, and that two live bream were put in either of the pails, why would not the pail to which the fish were added weigh more than the one to which no addition had been made? The Fellows were eager to satisfy the king's curiosity; but everybody gave a different answer. "One at length offered so ridiculous a solution that another of the members could not refrain from a loud laugh; when the king, turning to him, insisted that he should give his sentiments as well as the rest. This he did without hesitation, and told his Majesty, in plain terms, that he denied the fact! On which the king in high mirth exclaimed: 'Odds fish, brother, you are in the right.' The jest was not ill designed. The story was often useful to cool the enthusiasm of the scientific visionary, who is apt often to account for what never has existed."

The king could, however, discuss soberly the topics beloved by the F. R. S., who had many a long scientific talk with him. He tried experiments himself, and Pepys speaks of going down at Whitehall "into the king's little elaboratory under his closet; a pretty place; and there saw a great many chymical glasses and things but understood none of them." Pepys was accompanied by his fellow-members, Lord Brouncker and Sir R. Murray. Under date of May 3, 1661, Evelyn writes: "This evening I was with my Lord Brouncker, Sir Robert Murray, Sir Pa. Neill, Monsieur Zulichem, and Mr. Bull (all of them of our society and excellent mathematicians) to show his Majesty, who was present, Saturn's annulus very neere eclipsed by the moon; also Jupiter and satelites, thro' his Majesty's great telescope, drawing 35 foote; on which were divers discourses." Another day Evelyn accompanied Charles "to Mons. Febure, his chymist (and who had formerly been my master in Paris), to see his accurate preparation for the composing Sir Walter Raleigh's rare cordial; he made a learned discourse before his Majesty in French on each ingredient." Another scientist of high rank was Prince Rupert, who with his own hands (which the jeering courtiers said too often bore the stains of the laboratory) taught Evelyn to engrave mezzotinto, and whom Evelyn introduced to the Royal Society, where, in spite of smoke-begrimed linen and fingers stained with acids, the soldier chemist was warmly welcomed as an agreeable companion and scientific brother. The well-known "Prince Rupert's drops" may be numbered among the scientific toys invented in this age.

Pepys gives an amusing account of an encounter between Charles II and the celebrated scholar, wit, and inventor, Sir William Petty. "Thence to Whitehall," he says, "where in the duke's chamber the king come and stay'd an hour or two, laughing at Sir William Petty, who was there about his boat (one of his inventions); and at Gresham College in general; at which poor Petty was, I perceived, at some loss; but did argue discretely, and bear the unreasonable follies of the king's objections and other bystanders with great discretion, and offered to take odds against the king's best boats; but the king would not lay, but cried him down with words only. Gresham College he mightly laughed at for spending time only in weighing ayre and doing nothing else since they sat."

Some time before this Evelyn wrote: "I went with that excellent person and philosopher, Sir Robert Murray, to visit Mr. Boyle. At Chelsy I saw divers effects of the Eolipile for weighing aire!" Boyle was the discoverer of "the law of the air's elasticity."

Pepys, no doubt, while the king teased and jeered at Sir William Petty, was indignantly recalling the society's many fine experiments with colors, fire, loadstones, microscopes, the air-pump, thermometer, liquors, musical sounds, vibrations of the air, blood injected into a dog to prove Harvey's theory of circulation, and "one that did turn a piece of roasted mutton into pure blood, which was very rare"; and another, when the blood of a sheep was transfused into a man.

He would have liked to remind his Majesty of the plans for planting the royal forests with oaks and other trees; abating London smoke, and making artificial fuel, which had emanated from the society; of how they had promoted new physiological, surgical, medical, botanical, chemical, physical, astronomical, agricultural, horticultural, and sanitary methods and discoveries; patronized art. literature, architecture, and mechanical inventions, and were doing all in their power to "disperse," as Macaulay said of them, "the phantoms which had haunted the world for ages, and destroy the belief in witchcraft, astrology, and alchemy."

Yet, alas! Charles might have retorted that many of their leaders were either seeking the philosopher's stone and the elixir of life, endeavoring to fly in the air, to collect the feathers of the wing of a phœnix, or catch "the disjointed syllables of an old doting astrologer." The contents of their museums were often no more valuable than the toys in the baby-house, and amusing rather than useful or really curious. Yet with these playthings they expected to work wonders in science.

The distinguished Sir Samuel Morland, who was reputed to have invented the steam-engine, the speaking-trumpet, drum capstans for weighing heavy anchors, arithmetical wheels, quench-fires, a new kind of harp, valuable bridges, a machine for throwing water to a great height, and other useful things, prided himself on his coach, which contained a kitchen with a fireplace, pots, frying-pans, and a machine for roasting meat by clock-work.

Evelyn visited Sir Samuel when the inventor was very old and blind, and was shown his "invention of writing, which was very ingenious; also his wooden Kalender, which instructed him all by feeling, and other pretty and useful inventions of mills, pumps, etc. He has newly buried £200 worth of music-books six feet under ground, being, as he said, love-songs, and vanity. He plays himself psalms and religious hymns on the theorbo." Sir Samuel believed in spells and witchcraft, and hesitated to prosecute a lawsuit because he was firmly convinced that the defendant had used, or was capable of using, charms to gain the victory over him. One of the fantastic wonders of the age was the home of Winstanley, who built the first Eddystone lighthouse. If you kicked aside an old shoe, flung purposely in your way, "up started a ghost before you. If you sat down in a certain chair, a couple of gigantic arms would immediately clasp you in." The house was a perfect knickknackatory, as the people of that day would have said. The instant you seated yourself in an arbor built in the garden near a canal you "were sent out afloat into the middle of the canal, whence you could not escape till this man of art and science wound you up to the arbor." Evelyn gives an interesting account of the singular inventions of "that most obliging and universally curious" Bishop Wilkins, whose lodgings at Oxford he visited when the bishop was warden of Wadham College. Dr. Wilkins had contrived a talking statue, which was hollow, and connected with a tube through which a man a long distance off spoke the words which seemed to be uttered by the figure. With the assistance of that "prodigious young scholar, Mr. Christopher Wren," he had filled a gallery above his lodgings with a variety of shadows, dials, perspectives, and many other artificial, mathematical, and magical curiosities; a way-wiser, a thermometer, a monstrous magnet, conic and other sections, a balance on a demi-circle, marble curiously colored by Wren, and other scientific toys and instruments.

A favorite experiment in the seventeenth century was producing the apparition of a rose or other flower, and was called the process of the Palingenesis. "Having burnt a flower, by calcination, disengaged the salts from its ashes, deposited them in a glass vial, a chemical mixture acted on it, till, in the fermentation, they assumed a bluish and a spectral hue. The dust, thus excited by heat, shoots upwards into its primitive forms; by sympathy the parts unite, and while each is returning to its destined place, we see distinctly the stalks, the leaves, and the flower arise; it is the pale spectre of a flower coming slowly forth from its ashes. . . . This vegetable phœnix lies thus concealed in its cold ashes till the presence of heat produces this resurrection." When the ashes again cool it returns to death. "A corpse may give out its shadowy re-animation when not too deeply buried in the earth. Bodies corrupted in their graves have risen, particularly the murdered; for murderers are apt to bury their victims in a slight and hasty manner." Another scientific theory, as well as popular superstition, proved beyond peradventure by experiment!

Some members of the society were "impatient for romantic discoveries; miracles were required, some were hinted at, while others were promised." Of these wonders, Glanville, a man of acute and original intellect, who, though a firm believer in and defender of witchcraft, was yet somewhat skeptical in scientific matters, wrote in his work on the progress of knowledge since the days of Aristotle: "Should these heroes [the F. R. S.] go on as they have happily begun," he said, "they will fill the world with wonders; and posterity will find many things that are now rumors verified into practical realities. It may be, some ages hence, a voyage to the southern unknown tracts, yea, possibly, the moon, will not be more strange than one to America. To them that come after us, it may be as ordinary to buy a pair of wings to fly into remotest regions, as now a pair of boots to ride a journey; and to confer at the distance of the Indies, by sympathetic conveyances, may be as usual to future times, as to us in a literary correspondence. The restoration of grey hairs to juvenilty, and renewing the exhausted marrow, may at length be effected without a miracle; and the turning the now comparative desert world into a paradise, may not improbably be expected from late agriculture. Those that judge from the narrowness of former principles and successes will smile at these paradoxical expectations. Antiquity could not have believed the almost incredible force of our cannons, and would have as coldly entertained the wonders of the telescope." Disraeli smiles at these dreams at the dawn of philosophy. What would he have thought had Glanville prophesied of steamships, railroads, telegraphs, sewing-machines, telephones, and other inventions of the nineteenth century, which were unknown in Disraeli's lifetime?

Gold-making was a favorite pursuit in the seventeenth century with our scientists. Sir Kenelm Digby's devotion to alchemy, which he regarded as science, led him to lavish money on impostors, and seek knowledge from very unlikely sources. He once went in disguise to consult the philosopher Descartes, and, hoping to obtain from him the secret of making *aurum potabile*, complained that life was too short for the accomplishment of the designs of a scientist. Descartes, though he did not give Digby the recipe for the golden elixir, replied that he had considered that matter; "to render a man immortal was what he could not promise, but that he was very sure it was possible to lengthen out his life to the period of the patriarchs." Sir Kenelm's well-known weapon, salve, or powder of sympathy, was recommended by him as a valuable remedy, though it was, of course, the most ridiculous quackery. "The wound was never to be brought into contact with the powder, which was merely powdered vitriol. A bandage was to be taken from the wound, immersed in the powder, and kept there till the wound healed." He was a firm believer in astrology, and attributed his happy marriage to the beautiful and talented Venetia Stanley, after a somewhat protracted courtship, to astrological influences. Digby gave Evelyn, at Paris, in 1651, some water which he "intended for a disolvent of calx of gold," and which, though it smelled like aqua fortis, and tasted like vitriol, he insisted was "only raine water of the autumnal equinox exceedingly rectified, very volatile"; an assertion which led Evelyn to the conclusion that "Sir Kenelm was an arrant mountebank." Some time afterward, mentioning Digby's account of Lady Selenger's antipathy for roses, which he said she had to that degree that "laying but a rose upon her cheek when she was asleepe, it raised a blister," Evelyn remarks, "But Sir Kenelm was a teller of strange things."

Yet Digby had in Evelyn a not incredulous listener. In the winter of 1652 there lived in Paris, in extraordinary splendor and seeming wealth—the source of which was not apparent—an impostor, who nearly succeeded in selling Evelyn and his scientific friends a pretended secret for multiplying gold; but they discovered before the bargain was completed that the man was an egregious cheat. Not long afterward Evelyn visited Mark Antonio, a celebrated artist in enameling, from whom he heard strange tales concerning a Genoese jeweler, who, according to Antonio, "had the greate Arcanum, and had made projection before him severall times. He mett him at Cyprus travelling into Egypt, on return from whence he died at sea, and the secret with him, that else he had promised to leave it to him"—a legacy which the enameler believed would have enabled him to manufacture gold. Mark Antonio also told a marvelous story about a dwarfish person whom he saw come into a goldsmith's shop in Amsterdam, and ask the master to melt him a pound of lead, which, being done, the visitor threw into the crucible of molten metal a pinch of powder that he carried in the hollow pommel of his sword, and, after a few moments, pouring out a gold ingot from the crucible, he carried it off, saying, as he left the shop, "Sir, you will be paid for your lead in the crucible," where, sure enough, the goldsmith found four ounces of good gold; but he could never hear of the little transmuter of metals again, though he sought him throughout the city. "This," says Evelyn, who had seen so many wonderful new inventions during his travels in France and Italy, that he was in a continually expectant frame of mind, and almost ready to believe that projection powder was a scientific discovery—"this Antonio asserted with great obtestation, nor know I what to think of it, there are so many impostors and people who love to tell strange stories as this artist did, who had been a greate rover and spoke ten different languages." In May, 1653, Evelyn mentions in his diary the death from apoplexy of his "servant Hoare," meaning his private secretary, who "wrote those exquite severall hands," his illness being, it was supposed, caused by "tampering with mercury about an experiment in gold." The same year he records the receipt from Monsieur Roupel of "a small phial of *Aurum potabile,* with a letter showing the way of administering it and the stupendous cures it had done at Paris." But the bottle was empty when Evelyn received it, the potable gold having by some accident all run out. A drop of liquid gold was regarded as a sovereign remedy for every disease in France in the seventeenth century, as we may learn from Molière's Physician in Spite of Himself, and was called the universal heal-all.

In June, 1705, Evelyn speaks of going to see Dr. Dickinson, the famous chemist, and having a conversation with him about the philosopher's elixir, which the doctor believed attainable, having seen projection himself by "one Mundanus, who sometimes came among the adepts, but was unknown as to his country and abode."

Ashmole, of museum fame, though rather a theoretical than practical alchemist, also had faith in potable gold as well as in other superstitions. He writes in his diary, April 11, 1668: "I took early in the morning a good dose of the elixir, and hung three spiders about my neck, and they drove my ague away." He says that the alchemist, if he would succeed, must carry on his labors in secret, and not let any one know of his undertakings but his good angel and himself. Sir W. Petty told Pepys that he had left in his will sums of money to be given as prizes to persons who should make certain inventions, among others "to him that could invent proper characters to express to another the mixture of relishes and tastes. And says that to him that invents gold he gives nothing for the philosopher's stone; for (says he) they that find out that will be able to pay themselves!"

The Fellows of the Royal Society were much interested in anatomy, and sometimes witnessed dissections of men or animals. Pepys writes, July 3, 1668: "To an alehouse; met Mr. Pierce, the surgeon, and Dr. Clerke, Waldron, Turberville, my physician for the eyes, and Lowre to dissect severall eyes of sheep and oxen, with greate pleasure and to my greate information. But strange that this Turberville should be so greate a man, and yet to this day had seen no eyes dissected, or but once, but desired Dr. Lowre to give him the opportunity to see him dissect some." Turberville was a celebrated oculist, and was recommended to Pepys by that illustrious philosopher, Mr. Boyle.

The Royal Society were in the habit of inviting distinguished foreigners who visited London to attend their meetings. Evelyn writes, August 30, 1680: "I went to visite a French gentleman, one Monsieur Chardine, who, having ben thrice in the East Indies, Persia, and other remote countries, came hither in our returne ships from those parts, and it being reported that he was a very curious and knowing man, I was desir'd by the R. Society to salute him in their name, and to invite him to honour them with his company. Sir Jo. Hoskins and Sir Christopher Wren accompanied me. . . . He was sorry he could not gratify the curiosity of the Society at present, his things not being yet out of the ship, but would wait on them with them on his return from Paris, whither he was going next day, but with intention to return suddenly and stay longer here, the persecution in France not suffering Protestants—and he was one—to be quiet." Chardine went to the East in search of jewels and had become very rich. They "found him at his lodgings in his Eastern habit, a very handsome person, extremely affable, a modest, well-bred man, not inclin'd to talke wonders. He seem'd about 36 years old." Chardine was the author of the excellent and well-known volume of travels.

Frequently scientific parties visited the homes of English *virtuosi* who had cabinets of scientific or historical curiosities or inventions of their own to exhibit. Pepys mentions, May 1, 1665, meeting and joining Lord Brouncker, Sir Robert Murray, "the heart and soul of the Royal Society"; Dean Wilkins, and Mr. Hooke, curator of the society, who were going by boat and coach to dine with the inventor, Colonel Blount, and witness "the trial of some experiment about making coaches easy." After admiring their host's "long spring coach" and dining with him, the party went to Deptford, and "into Mr. Evelyn's (Sayes Court), which is a most beautiful place. . . . A lovely and noble ground he hath indeed. And among other varieties a hive of bees, so as being hived in glass, you may see the bees making their honey and combs mighty pleasantly. . . . It being dark and late I stayed not; but Dean Wilkins and Mr. Hooke and I walked to Redriffe; and noble discourse all day long did please me."

The transparent apiary to which Pepys alludes was a present from Dr. Wilkins, who invented it, to Evelyn. It was regarded as so great a curiosity that Charles II made an excursion to Sayes Court expressly to see it. Evelyn described the hive as built like a castle or palace, adorned with little statues, dials, and vanes, and so contrived that the honey could be removed without injuring the bees. Evelyn was a scientific horticulturist, and his gardens and orchards were the wonder and admiration of his contemporaries, one of whom described his grounds as a "garden exquisite and most boscaresque, and as it were an exempler of his book of forest trees"—the famous Sylva written for the Royal Society at the request of the Admiralty Board. August 4, 1665, Evelyn writes: "I call'd at Durdans, where I found Dr. Wilkins, Sir William Petty, and Mr. Hooke, contriving chariots, war rigging for ships, a wheele for one to run races in, and other mechanical inventions; perhaps three such persons together were not to be found elsewhere in Europe for parts and ingenuity." Petty made fame and fortune by his inventions. Evelyn writes in 1655: "Came that renowned mathematician Mr. Oughtred to see me, I sending my coach to bring him to Wotton, being now very aged. Among other discourse he told me he thought water to be the philosopher's first matter, and that he was well perswaded of the possibility of their elixir; he believed the sun to be a material fire, the moone a continent, as appears by the late selenographers; he had strong apprehensions of some extraordinary event to happen in the following yeare, from the calculation of coincidence with the diluvian period; and added that it might possibly be to convert the Jewes by our Saviour's visible appearance or to judge the world." Such was the mixture of sense and nonsense which occupied the minds of superior men in the seventeenth century!

September 10, 1676, Evelyn mentions dining with the first astronomer royal, "Mr. Flamstead, the learned *astrologer* and mathematician, whom his Majesty had established in the New Observatorie in Greenwich Park furnished with the choicest instruments. An honest, sincere man."

Evelyn believed that diseased children had been healed by baptism, and that there were other well-attested modern miracles, and is careful to state that he planted the orchard at Sayes Court in the full of the moon; yet he was less credulous than many of his learned colleagues. In 1670 "a plaine, ordinary, silent working wench," whose arm three different times in July was powdered with red crosses arranged in a diamond-shaped figure, was brought to Sayes Court by friends who regarded this poor girl's malady as the result of a miracle, and wished the opinion on the case of an F. R. S. Evelyn was reminded of the "impostorious nunns" of Loudune, France, whom he had seen, and remembered that M. Monconys "was by no means satisfied with the stigmata of those nunns because they were so shy of letting him scrape the letters, which were Jesu, Maria, Joseph, as I thinke, observing they began to scale off with it, whereas this poor wench was willing to submit to any trial; so that I profess I know not what to think of it, *nor dare I pronounce it anything supernatural.*" "Curing by the touch," animal magnetism, or hypnotism, was not unknown in London in the seventeenth century, and "Gretrex and Stroaker" is mentioned in the Transactions of the Royal Society.

The members of the Royal Society considered themselves "intolerable losers" when prevented from attending the profitable and desirable meetings at Gresham College. "I now and then," one complains, "get a baite at Philosophy; but it is so little and jejune, as I despair of satisfaction 'till I am againe restor'd to the society, where even your very fragments are enough to enrich any man that has the honour to approach you." He calls heaven the Royal Society above, "where those whose refined and excellent natures make them capable of the sublimest mysteries, and aspire after experimental knowledge, truly so called, shall be fill'd; and there without danger taste of the fruit of the tree which cost our unhappy parents so dear, shall meet with no prohibition of what is desirable, no serpent to deceive, none to be deceived."

Many of the members of the Royal Society, while distinguished for their patient industry, could not philosophize on the facts they had collected, and their grammar and literary style were open to criticism. Their published works were consequently ridiculed by their ever-watchful opponents. One chief victim of the wits was Sir Hans Sloane, noted, like Ashmole, for his museum. The brilliant Dr. King produced a parody or travesty on Sloane's valuable history of Jamaica (quoting verbatim his bulls and blunders), which is "one of the severest and merriest satires that was ever written in prose." Yet we find the society, as early as 1665, appointing a committee to consider the improvement of the English language. And in Evelyn's correspondence appears a long letter addressed to Sir Peter Wyche, Knt., chairman of the committee, in which he says that they ought to prepare manuals of grammar, orthography, and punctuation, and a lexicon of current, obsolete, and technical words. Out of this grew a project for the establishment of an institution similar to the French Academy. "And, indeed," writes Evelyn to Pepys, in 1689, "such was once designed since the Restauration of Charles II (1665), and in order to it three or four meetings were begun at Gray's Inn by Mr. Cowley, Dr. Spratt, Mr. Waller, the Duke of Buckingham, Matt Clifford, Mr. Dryden, and some other promoters of it. But by the death of the incomparable Mr. Cowley, distance and inconvenience of the place, the contagion and other circumstances intervening, it crumbled away and came to nothing; what straw I had gathered towards the bricks of that intended pyramid (having the honor to be admitted an inferior laborer) you may command and dispose of, if you can suffer my impertinences; and that which I have not shew'd you, the plan I drew and was laying before them for that designe, which was, I say'd, the polishing of the English tongue, and to be one of the first intentions and chiefest subjects of the Academists."

The mental act of associating colors with words, etc., was observed in 1848 by Thoreau, who wrote to Emerson that his Ellen said that she could tell the color of a great many words, and amused the children at school by so doing.

SKETCH OF JOHN COUCH ADAMS.

ONE of the most striking illustrations of the value and range of man's reasoning faculty is afforded by the substantially simultaneous calculation, on a purely mathematical basis, of the elements of the then unseen and unknown planet Neptune, and the prediction of the place in the sky where it would be found on a given day, by the Englishman Adams and the Frenchman Leverrier. While Leverrier succeeded in first attracting public attention to his work, Adams anticipated him in beginning the calculation and in bringing it to a satisfactory result.

Prof. J. W. S. Glaisher treats Adams's first paper, by means of which the new planet might have been discovered, as furnishing the final and inexorable proof of Newton's law of gravitation; and the day when it was taken to Greenwich—October 21, 1845—as therefore marking a distinct epoch in the history of gravitational astronomy.

John Couch Adams was born at Lancast, seven miles west of Launceston, Cornwall, England, June 5, 1819, and died at the observatory in Cambridge, January 21, 1892. His father was a tenant farmer; his mother had a small landed estate of her own, and had inherited her uncle's library, in which were a few books on astronomy. He was interested in these books, and made rapid progress at the village school, and was learning algebra before he was twelve years old, at which age he went to a private school at Devonport, where he had Mr. Grylls, a cousin of his mother's, as his teacher. While he studied, as usual, the classics and mathematics, astronomy was his favorite branch, and he was making notes and drawing maps of the constellations when fourteen years old; he read eagerly all the astronomical books he could find, and soon became interested, by the perusal of Vince's Fluxions, in the higher mathematics. In 1837 it was contemplated to send him to the University of Cambridge; in October, 1839, he entered St. John's College of that university. During his undergraduate career, according to Prof. J. W. L. Glaisher, he was invariably the first man of his year in the college examinations. In 1843 he was graduated as senior wrangler, being also first Smith's prize-man. The occurrence of a small constellation of mathematical senior wranglers at Cambridge about this time is noted in one of the biographies of Adams, viz.: Stokes in 1841, Cayley in 1842, and Adams in 1843—all three of whom have since been professors, and famous. Adams was elected a Fellow of his college on the year of his graduation, and continued in that relation till 1852, when, he not having taken holy orders, his fellowship expired. In the next year he was elected to a fellowship in Pembroke College.

It was while still an undergraduate that Adams began the investigation of the irregularities of Uranus, that culminated in the discovery of the new, remote planet Neptune. The possibility of the existence of such a planet, acting upon the motions of Uranus, had been suggested by Bouvard in 1821. Mr. Adams's attention was drawn to the subject, according to Prof. Glaisher, by reading Airy's report upon recent progress in astronomy in the British Association volume for 1832–'33. On July 3, 1841, at the beginning of his second long vacation, when he was in his twenty-third year, he made the memorandum, "Formed a design at the beginning of this week of investigating, as soon as possible after taking my degree, the irregularities in the motion of Uranus which are yet unaccounted for; in order to find whether they may be attributed to the action of an undiscovered planet beyond it; and, if possible, thence to determine the elements of its orbit, etc., approximately, which would probably lead to its discovery."

Prof. Glaisher further relates the history of the calculations: "In 1843, the year in which he took his degree, he attempted a first rough solution of the problem, on the assumption that the orbit was a circle with a radius equal to twice the mean distance of Uranus from the sun. The result showed that a good general agreement between theory and observation might be obtained. In order to make the data employed more complete, application was made, through Prof. Challis, to the astronomer royal, for the results of the Greenwich observations of Uranus. When they were obtained, Adams undertook a new solution of the problem, taking into account the most important terms depending on the first power of the eccentricity of the orbit of the supposed disturbing planet, but retaining the same assumption as before with respect to the mean distance. In September, 1845, he communicated to Prof. Challis the values which he had obtained for the mass, heliocentric longitude, and elements of the orbit of the assumed planet. The same results, slightly corrected, he took with him to the Royal Observatory, Greenwich, on October 21, 1845. The paper which he left at the observatory on this occasion also contained a list of the residual errors of the mean longitude of Uranus, after taking account of the disturbing effect of the new planet, at dates extending from 1690 to 1840." Prof. Challis began the search for the planet on July 29, 1846, three weeks before it was in opposition, and continued the observations for two months. His plan was to sweep a zone covering the computed place of the body, and extending over 30° of longitude and 10° of latitude. "For the first few nights the telescope was directed to that part of the zone in the immediate neighborhood of the place indicated by theory. Unfortunately, the observations were not immediately compared with each other, or Prof. Challis would have discovered, what he afterward found to be the case, that he had actually seen the planet on August 4th and August 12th, the third and fourth nights of observation. . . . On September 3, 1846, Adams communicated to the astronomer royal a new solution of the problem, supposing the mean distance of the planet as originally assumed, to be diminished by about the thirtieth part. The result of this change was to produce a better agreement between the theory and the later observations, and to give a smaller and therefore a more probable value of the eccentricity."

Leverrier's first paper relative to the subject was presented to the French Academy on November 10, 1845, and concerned the perturbations of Uranus produced by Jupiter and Saturn; but in it he also pointed to irregularities which could not be accounted for by the existing theory. In his second paper, June 1, 1846, he expressed the conclusion that the unexplained irregularities were due to an undiscovered planet exterior to Uranus. He calculated the longitude, but did not give the elements of the orbit of the disturbing planet. The place assigned by him to the supposed body differed by only one degree from that given by Adams in the paper which he had left at the Greenwich Observatory seven months earlier.

"Adams's researches," says Prof. Glaisher, "therefore preceded Leverrier's by a considerable interval; and in spite of the delay in carrying out the search, it had been carried on at Cambridge for nearly two months before the planet was found at Berlin. Adams's investigation may be regarded as having been completed on October 21, 1845, when he left his paper at the Royal Observatory. This was three weeks before Leverrier's memoir, showing that the irregularities could not be attributed to any of the known planets, was presented to the French Academy, and more than seven months before the presentation of Leverrier's second memoir. It is to be noticed that in this second memoir Leverrier did not give the elements of the orbit or the mass of the planet, which were contained in Adams's paper of October 21st."

A bitter controversy ensued over the question of priority in discovery, in which Mr. Adams took no part. He felt and expressed a warm appreciation for Leverrier; met him with great pleasure at Oxford in 1847; and was visited by him in the same year at Cambridge. A story was told of him for the first time by Dr. Donald MacAlister at the commemorative meeting at St. John's College, February 20, 1892, to the effect that several years ago, when a memorial volume was prepared to be presented to M. Pasteur as a testimonial of the appreciation of English men of science for his labors, Prof. Adams subscribed his name, writing beneath it the motto, "*Hommage au compatriote de Leverrier.*"

The small number and volume of Prof. Adams's publications, after his calculations for the planet Neptune, have been remarked upon. He was, however, an industrious worker, calculating in every quarter of the mathematical field and in mathematical astronomy, and is said to have left a large mass of manuscript work, much of which is expected to prove valuable. The Adams prize, of about four hundred dollars a year, to be awarded every two years to the author of the best essay on some subject of pure mathematics, astronomy, or other branch of natural philosophy, was instituted by members of St. John's College soon after the discovery of Neptune, as a testimonial to the honor conferred on the college and the university by the investigation. In 1848 Mr. Adams began the determination of the constants in Gauss's theory of terrestrial magnetism. He resumed the work and was occupied with it in the later years of his life, but had not completed it at the time of his death. In 1852, having been elected in the previous year President of the Royal Astronomical Society for two years, he communicated to the society new tables of the moon's parallax, to be substituted for those of Burckhart. These tables were printed in the appendix to the Nautical Almanac for 1856.

His memoir explaining the secular variation of the moon's mean motion was communicated to the Royal Society in 1853. The problem baffled solution. The French Academy had at different times given prizes for explanations to Euler and Lagrange, but neither of these mathematicians had been able to discover any secular term; and Euler, considering it established that such a term could not be produced by the principles of gravitation, had recourse to the supposition of a resisting medium. Laplace announced in 1787, as the true cause of the phenomenon, the gradual diminution in the mean action of the sun produced by the secular variation of the eccentricity of the earth's orbit. Theories were also proposed by Damoiseau and Plana, agreeing in principle with Laplace's, but differing slightly in the numerical values assigned to the acceleration. Adams found that Laplace's explanation of the phenomena was essentially incomplete, and suggested corrections to all the theories. Some controversy ensued, at the end of which Prof. Adams was sustained. A calculation of the same problem, made by Prof. Airy in 1880, was also corrected by Prof. Adams.

Mr. Adams was appointed, in the fall of 1858, Professor of Mathematics in the University of St. Andrews, where he continued his lectures till the end of the session, in May, 1859; and late in 1858 he was made Lowndean Professor of Astronomy and Geometry at Cambridge. He held the last position till his death.

A part of his work in it was to lecture during one term in each year, generally on the lunar theory, but sometimes on the theory of Jupiter's satellites or the figure of the earth.

In 1867 he published an account of the results he had obtained with respect to the orbit of the November meteors, in the investigation of which he had co-operated with Prof. H. A. Newton, using the data and observations furnished by him. These calculations took notice of all the perceptible effects produced by the planets, and established the correctness of the period of thirty-three and a quarter years for the revolution of the meteoric body. In order to obtain a sufficient degree of approximation, it was necessary to break up the orbit of the meteors into several different parts, for each of which separate calculations had to be made. Prof. Adams afterward subdivided certain parts of the orbit of the meteors into still smaller portions, with a view of obtaining a closer approximation. The calculations on this subject have not been published, but they exist among his papers, and seem to be fairly complete.

A paper communicated to the Astronomical Society, in November, 1877, embodied a review of a memoir by Mr. G. W. Hill, of Washington, on the part of the motion of the moon's perigee, which is a function of the mean motions of the sun and moon. This paper is pronounced by Prof. Glaisher peculiarly interesting, because in it the author expresses his own views with respect to the mathematical treatment of the theory of the moon's motion. He seems to have preferred to treat the subject by its special problems; while he had great admiration for Delaunay's general theory.

Prof. Adams also paid much attention to pure mathematics, and treated many abstruse problems in a highly technical manner, in papers the very titles of which are an unknown language to all but accomplished mathematicians.

A large mass of papers which Sir Isaac Newton had left at his death, having been left to the University of Cambridge by Lord Portsmouth, it became Prof. Adams's task to arrange and catalogue the mathematical part of the collection. The work lasted many years, but proved very interesting to Prof. Adams, by casting light on the methods by which Newton had worked out his results.

On the resignation by Prof. Challis of the directorship of the observatory at Cambridge in 1861, Prof. Adams was appointed to succeed him, while he still continued in the Lowndean professorship. In 1870 the observatory began to co-operate in the scheme of the *Astronomische Gesellschaft* for the observation of all the fixed stars in the northern hemisphere down to the ninth magnitude, the observations being put under the charge of the first assistant, Mr. Graham. The zone assigned to the observatory was that between 25° and 30° of north declination. As related to this work, Prof. Adams gave, in an appendix to one of the volumes of the Cambridge Observations, the formulæ and instructions which he had drawn up many years before for the formation of a proposed new fundamental catalogue, together with the mean places of the eighty-four fundamental stars from 1830 to 1870.

Prof. Adams was President of the Royal Astronomical Society in 1851–1853, and in 1874–1876, and had the honor of delivering the addresses in presenting the gold medal to Dr. Peters, Dr. Hind, D'Arrest, and Leverrier. In 1870, as vice-president, he delivered the address on the presentation of the medal to Delaunay. He himself received the medal in 1866 for his contributions to the development of the lunar theory. He received the Copley medal of the Royal Society in 1848. In 1881 he declined an offer of the position of astronomer royal. In 1884 he was one of the British delegates to the International Prime Meridian Conference, which met in Washington. He received honorary degrees from Oxford, Dublin, Edinburgh, the University of Bologna, and his own university; and he was a correspondent of numerous foreign learned societies.

Among his peculiar tastes in work Prof. Glaisher mentions the enjoyment he took in making calculations that called for long lines of figures, as illustrated in his calculation of Euler's constant to 263, and of some logarithms to 273, places of decimals. Few of his papers were produced spontaneously. In the majority of cases he was induced to give an account of some investigation of his own by the publication of a paper by some one else in which the same subject was treated. He was able to map out beforehand in his head the whole course of an investigation; and he rarely began to write till he had carefully thought out his subject, when he wrote straight on without interruption.

While astronomy and mathematics were his professed studies, he was interested in other branches of knowledge, was a man of most extensive general reading, was much attracted to special pursuits, and made a valuable collection of early printed books. His moral and intellectual qualities were well balanced.

Prof. Adams was attacked by a severe illness in October, 1889, but recovered and continued his mathematical work for several months. He was again attacked in June, 1890, by an illness from which he never fully recovered.

EDITOR'S TABLE.

PROGRESSIVE THEOLOGY.

WE note with great pleasure the issue by Messrs. Houghton, Mifflin & Co., of Boston, under the title of The New World, of a theological periodical which seems to us to be designed on truly progressive lines—to be, that is to say, rather an organ for the discovery of truth on all matters connected with theological belief than for the propagation or defense of the views of any particular theological school. The magazine is under the editorial management of Messrs. C. C. Everett, C. H. Toy, Orello Cone, and N. P. Gilman, names which of themselves vouch for the broad and liberal spirit in which the new enterprise is conceived, and for the scholarship which will be placed at its service. These gentlemen, in an editorial note, state that they " have no distrust of the scientific temper which, in many spheres of investigation, has accomplished such great results, or of the critical spirit which has led the way to a better understanding of every literature to which it has been applied." The number before us contains articles by Lyman Abbott, C. C. Everett, J. G. Schurman, W. R. Alger, C. H. Toy, J. Estlin Carpenter, Thomas R. Slicer, Edward H. Hall, and Charles B. Upton, as well as book-reviews by various hands. In all we note a liberal spirit worthy of this new departure in theological literature. Here and there, perhaps, there is a little lack of scientific exactness, as where Dr. Lyman Abbott professes to discover the " evolution of Christianity " in the fact that, while Jesus succeeded in feeding " five thousand men, besides women and children, seated in serried ranks on the ground," in our own day, " an organized benefaction, through the consecrated channels of commerce, so distributes to the needs of man that, in a truly Christian community, a famine is well-nigh impossible." Other articles, however, furnish a guarantee that, within the new review itself, such weak and, we must say, delusive analogies will not pass unchallenged. For example, in discussing The New Orthodoxy, Mr. Edward H. Hall deals in a very thorough-going manner with the evasions of what may be called the pseudo-liberal school—those who welcome criticism so long as it is not " destructive ": as if the function of criticism were never to destroy —and who, in a general way, take back with one hand what they seem to give with the other. Mr. Hall might be fully trusted to point out to Dr. Abbott that, if the feeding of the multitude by Jesus was a mere matter of commissariat, the vaster distributions of to-day point to an evolution in social organization, not to an evolution of Christianity; while if the multitude were fed by a miracle, as the Christian world has hitherto believed, what we see to-day has no relation to it whatever. Mr. Hall contends, and rightly, that if the aid of criticism is to be invoked at all, it is vain to attempt to circumscribe its action. " Whoever," he says, " invokes the name of Science, invokes a great name. He calls to his aid a master, not a servant. Science has its own domain and, in that domain, its own laws and its own rights. It can not be dictated to; it dictates. It suffers no one to assign its limits, but goes wherever there is work for it to do. Wherever there is question of evidence, argument, testimony, or proof, there the scientific method belongs; and, once admitted, it must be given full play." These are brave words, and, if The New World shall present a selection of articles written in frank acceptance of these principles, it will deserve well of all lovers of the truth, even though some of its writers may cling to less defensible positions. There is a great work for our new contemporary to do in freeing the religious sentiment from delusions which only serve to check its free expansion and development. Many now think that, in some mysterious manner, they ingratiate themselves with higher powers by disparaging and abusing their reasoning faculty; but The New World, if we do not mistake its mission, is prepared to teach a different lesson—namely, that the fullest development and greatest activity of the reasoning faculty are absolutely essential to the highest religious life. When man is a free being in the largest sense of the word, and has reconciled himself, once for all, to the conception of all-pervading law, his religious nature may then reach out for its own satisfactions, not only without dread of aught which it may be in the power of Science to reveal, but with a glad confidence that all further discoveries can only tend to a deepening of that spirit of reverence and self-reverence in which religion essentially consists. Science at last is coming into its own in this world in which its mission has so often been ignored or misunderstood, and in which the labors and sacrifices of its votaries have so often been repaid with persecution and reproach. The New World is a hopeful sign of the times, and we bespeak for it a liberal support from those who believe that, in religion as in science, there are better things in store for us than the world has yet seen.

COMMON SENSE WANTED.

Every day some new law is passed somewhere or other to protect people against the results of their own ignorance and folly; but it is comparatively seldom that we hear of any proposition of a serious or comprehensive kind to do away with the ignorance and folly which render, or seem to render, so many laws necessary. Popular education is believed by some to be doing this work about as fast as it can be done; but this we hold to be a serious error. There never was a time, we believe, when so many people were trading on the thoughtlessness and credulity of the masses as at present. The Post-Office Department spends a considerable percentage of the energy which it should devote to perfecting the mail service of the country in unsuccessful efforts to prevent the mails from being used to promote fraudulent schemes. The result, doubtless, is to more or less embarrass some swindling businesses; but as fast as one is suppressed another takes its place, and some that seem to have been suppressed have only changed their name and perhaps their base of operations. But, in addition to schemes that are unmistakably fraudulent, there are hundreds of at least dubious character that spread their nets in the advertising (sometimes even in the editorial) columns of the press. No offer is too grossly extravagant to captivate and delude some persons who might be supposed able to take care of themselves in an ordinary business transaction. We have known a man who could write a fair business letter send a dollar in response to an advertisement which stated that, for that sum, the advertiser would send a complete set of parlor furniture in black walnut and crimson plush to any address, carriage paid. This intelligent gentleman was very angry because, in return for his dollar, he got a few toy articles made of chips and rags and inclosed in a pasteboard box about six inches long by three broad, the whole thing weighing only a few ounces. The protests which he addressed, as we are informed, to the postal authorities were conceived in a fine tone of moral indignation, though the only part which the post-office had taken in the matter had been to convey to him a most harmless consignment of goods. So far as we could learn, it never occurred to him to pronounce himself an ass of high degree, and not only an ass but an actual aider and abettor of fraud, seeing that it is just the silly persons who expect to get something for nothing who keep the army of cheats in provender.

This idea of getting something for nothing is indeed the main-stay and support of far the larger part of the fraud that exists in the world; and the first lesson in practical wisdom is to learn that the thing is impossible, and that nobody professes to give something for nothing, or large value in exchange for small value, except for some selfish and dishonest purpose. We have discussed the subject before in these columns, and again we ask, Why could not a special effort be made in our educational institutions, not merely to put the young on their guard against being deceived, but to call forth their contempt for all the dishonest and semi-dishonest devices which now exercise so great an attraction over the masses? Why should not the lesson be taught with iteration that the best way to get what we want is to give an honest equivalent for it, and that if this principle were more generally recognized everybody would get better value for his money or his labor than is now the case? The promoters of fraudulent enterprises are mere social parasites; they give no value, or at least no decent value, for the money they rake in, and the real workers of society have to tax themselves that these men may flourish. As to the word-making, text-finding, bean-guessing plans and devices which are so freely advertised, they ought to be beneath the contempt of all but the very weakest intellects in the community; yet how many people who can not be placed in that category take more or less interest in such things! "With all thy gettings," said one of old, "get understanding." Doubtless he meant common sense; and, if he spoke at all in the spirit of prophecy, he probably foresaw the time when, under a state-stimulated system of education, the intellectual gettings of people would be greatly increased in number, and yet common sense be very frequently left out.

LITERARY NOTICES.

Social Statics, abridged and revised; together with The Man *versus* The State. By Herbert Spencer. New York: D. Appleton & Co. Pp. 420. Price, $2.

Social Statics was Mr. Spencer's first book. As originally issued, in 1850, it bore the title Social Statics: or, the Conditions essential to Human Happiness specified, and the First of them developed. It was put forth as, in the words of the author, "a system of political ethics—absolute political ethics, or that which ought to be, as distinguished from relative political ethics, or that which is at present the nearest practicable approach to it." Mr. Spencer affirms at the outset that, living as they do in the social state, men can attain the greatest happiness only by seeking it indirectly. He then reasons out as a first principle controlling the pursuit of happiness that "every man has freedom to do all that he wills, provided he infringes not the equal freedom of any other man." Applications of this first principle constituted the rest of the original volume. Many of these applications, in a matured and completed form, have been comprised in the division of Mr. Spencer's Synthetic Philosophy dealing with Justice, hence they have been omitted from the new edition of the present work, or presented only briefly. The last eight chapters of the book, however, which treat of the regulation of commerce, education, currency, postal arrangements, and some similar functions commonly performed by governments, remain substantially as first published.

Besides the duplication of a large part of this work in Justice, another reason for revising Social Statics was that, in the years that have passed since it first appeared, Mr. Spencer had relinquished some of the conclusions drawn from its first principle, and had given up also one of the bases upon which he had formerly made that principle to rest. The omission of some parts was accordingly necessary in order to check misrepresentations of the views which he now holds.

Interesting indications of the direction in which Mr. Spencer's thought was tending forty years ago may be found scattered through this volume. Thus, on page 32 he declares that civilization is a part of Nature, hence its progress is all of a piece with the development of an embryo or the unfolding of a flower; and, provided that the constitution of things remains the same, this progress must result in the perfection of mankind. Again, on pages 121, 122 is a paragraph illustrating the specialization of functions and the adaptation of parts to their duties which goes on in the development of various kinds of organisms. This paragraph shows that in 1849, when it must have been written, Mr. Spencer had already entered upon the line of thought which led him up to the general law of evolution. Several passages give evidence that he had then discovered the operation in Nature of the process that has since become known under the name "natural selection." Thus on pages 203, 204 he says, "Partly by weeding out those of lowest development, and partly by subjecting those who remain to the never-ceasing discipline of experience, Nature secures the growth of a race who shall both understand the conditions of existence and be able to act up to them."

The Man *versus* The State consists of four essays combating paternalism, which were originally published as magazine articles, and are among the most able and vigorous of Mr. Spencer's miscellaneous writings. A postscript and a note have since been added.

Outlines of Lessons in Botany. Part II. Flower and Fruit. By Jane H. Newell. Boston: Ginn & Co. Pp. 399. Price, 90 cents.

The leading aim in this work is to direct pupils to the study of plants themselves. With the very practical purpose of securing sufficient material for study, the successive lessons deal with the flowers in season in New England and vicinity, to which region the book is specially adapted, from March to early summer. A few house-plants are introduced to help out the scanty blossoms of March. Later, wild flowers, the blossoms of forest trees and fruit trees, and the flowers of garden vegetables all receive attention. While the analysis of flowers occupies the greater part of this volume, attention is given also to the leaves, stem, and roots of the specimens studied. An appendix contains a schedule for plant description, with some fifty or sixty descriptions following this form. There are also a glossary, an index of plants, and a chart comprising sixty families designed to introduce pupils to the use of Gray's Manual. There are thirty-seven illustrations.

A History of Epidemics in Britain (664–1666). By Charles Creighton, M. A., M. D. New York: Macmillan & Co. Pp. 706. Price, $4.50.

The pestilence of 664 in England, known to tradition as the great plague "of Cadwallader's time," furnishes the starting-point for this history. But little can be told about this pestilence, for, besides an entry in the Irish annals, Beda's Ecclesiastical History is the only source of authentic information concerning it. Previous to the "black death" of 1348–'49, English epidemics were almost all famine-sicknesses. The author gives a chronological list of such pestilences, embracing more than forty, with full accounts of three of them, and notes concerning others. An early chapter is devoted to Leprosy in Mediæval Britain, from which it appears that much consideration was given to lepers in the middle ages, these unfortunates being deemed the special wards of Jesus Christ. The author believes, however, that the hundred or more hospitals mentioned under the name of lazar-houses in Dugdale's Monasticon were not exclusively for the care of lepers. Furthermore, contemporary descriptions of lepers indicate that several diseases were then known by the common name of leprosy.

The black death, or bubo-plague, of 1348–'49, produced a frightful mortality. Certain parish records show ten times the ordinary number of burials. During the fourteen months of its prevalence two thirds of the clergy of Britain were carried off, and one half of the whole population of London. Dr. Creighton's account of this pestilence includes an examination of the traditions which locate its origin in China and in Tartary, and a discussion of the theory of the bubo-plague. The social and economic consequences of the black death make up an interesting chapter, and connect this history with the general history of the time. The next remarkable epidemic was the sweating-sickness, of which five outbreaks occurred between 1485 and 1551. The record of plague in the Tudor period is a story of frequent outbreaks, one of the most serious being the London plague of 1563. Jail-fevers, influenzas, etc., during the same period furnish material for another chapter. The "French pox" has a chapter by itself, another is devoted to small-pox and measles, and another to scurvy and other sicknesses attendant upon early voyages. The plagues of the seventeenth century down to 1665 are duly recorded, and then comes the "Great Plague," to which over twenty per cent of the population of London succumbed. The extinction of the plague in England, in 1666 or 1667, brings this history to a close. The work gives evidence of much thoroughness and great ability on the part of its author, and deserves to rank high in medical literature.

The Last Words of Thomas Carlyle. New York: D. Appleton & Co. Pp. 383. Price, $1.75.

This volume contains Wotton Reinfred, a romance; and An Excursion (futile enough) to Paris, which were left among the author's papers at his death; and a number of letters written by Carlyle to Varnhagen von Ense in the years 1837 to 1857; together with two notes of Varnhagen about Carlyle's first visit to Berlin in 1852; and letters of Jane Welch Carlyle to Amily Bölte, 1843 to 1849. The romance, Wotton Reinfred, is Carlyle's only essay in fiction, and therefore possesses a distinctive interest. It was probably written soon after the author's marriage, and represents the earlier period of his literary development. In it the editor of the volume finds the first expression of ideas and doctrines afterward set forth with more formality in Sartor Resartus. Mr. Froude regards it as of considerable interest, from the sketches which it contains of particular men and women, who being now dead, and the incidents forgotten, any objection which may have existed to publication is now removed. Among these characters, according to Mr. Leslie Stephen, is "a curious portrait of Coleridge, thinly veiled." The Excursion to Paris is the unreserved daily record of a journey in company with the Brownings, when Carlyle paid a visit to Lord Ashburton. It presents a singularly vivid picture of the author's personality, and one which adds something to our knowledge of Carlyle the man.

Annual Report of the Board of Regents of the Smithsonian Institution, to July, 1890. Pp. 808. Report of the National Museum, for the Year ending June 30, 1889. Pp. 933. Washington: Government Printing-Office.

The permanent funds of the Smithsonian Institution, bearing interest at six per cent, amount to $703,000. The inadequacy and insecurity of the buildings continue to be subjects of complaint. The Institution was able during the year covered by the report to do rather more for the encouragement of original research than it had done for several years past. The project for securing an astro-physical observatory and general laboratory had assumed definite shape. Solid foundation piers had been built under the temporary shed, and a number of instruments had been procured, of which the siderostat is probably the largest and most powerful instrument of its class ever constructed. The work of exploration was carried on through the Bureau of Ethnology and the National Museum; and some rare and valuable collections were obtained. A few small grants from the Smithsonian fund, "commensurate rather with the abilities of the Institution than with its wishes," were made to aid in physical science—in addition to the aid largely given to biological and ethnological science through the Museum, Bureau of Ethnology, and Zoölogical Park. One of the important features of the year's history of the Institution was the passing of the National Zoölogical Park under its control. A complete description of the park is given. The general appendix, which constitutes the larger part of the volume, contains a miscellaneous selection of papers, some of them original, embracing a considerable range of scientific investigation and discussion. The National Museum now contains not far from three million specimens. The increase during the year covered by the report is much smaller than in any previous year since the completion of the Museum building. The difference is accounted for to a large degree by the fact that the exhibition rooms and storage halls being filled to their utmost capacity, it has become necessary to cease to a large degree the customary efforts to add to the collections. Besides other features, accounts are given of work in the scientific departments, the library and publications, the work of the Museum preparators, accessions, co-operation of bureaus and officers of the Government, and explorations; considerable space is given to describing the participation of the Smithsonian Institution and the Museum in Centennial Exhibitions at Cincinnati and Marietta, Ohio; and eight papers are published describing and illustrating collections.

Games, Ancient and Oriental, and how to play them. By Edward Falkener. London and New York: Longmans, Green & Co. Pp. 366. Price, $6.

The author believes in the usefulness of games because they afford needful relaxation to the mind, pleasant diversions to the invalid and the afflicted, and means of bringing friends together and promoting acquaintance and fellowship. He directed his attention many years ago to the games of chess, draughts, and backgammon, and to the formation of magic squares. Elaborate works have been written on the history of these games, and instead of exploiting this branch of the subject over again, he has preferred to discuss the practical rules and principles of each game. He expresses the opinion that students may find that the games which were established in years gone by contain merits that are not always found in the new and fanciful conceits of the day. The first place is given to the games of the ancient Egyptians, with the results of Dr. Birch's researches on the subject. The games are Tau, or Robbers, which was afterward played and called by the same name, *Ludus Latrunculorum*, by the Romans; *Senat*, which is still played by the modern Egyptians as *Seega;* Han, or the game of the Bowl; the Sacred Way, the *Hiero Gramme* of the Greeks; and *Atep*, which is played by Italians as Mora. Under the head of chess are given Indian, Chinese, Burmese, Siamese, Turkish, Tamerlane's, and double chess, and the game of the Maharajah and Sepoy; of draughts, Polish and Turkish draughts, *Wei-K'i* and *Go*, or the Chinese and Japanese game of inclosing; German, Turkish, and Indian backgammons. A considerable variety of magic squares are described, and all the games are illustrated with photographic reproductions and with diagrams.

The Oak: a Popular Introduction to Forest Botany. By H. Marshall Ward, F. R. S., F. L. S. Modern Science Series, No. III. New York: D. Appleton & Co. Pp. 175. Price, $1.

For many persons trees have an interest which is not possessed by the lowlier members of the vegetable kingdom. Trees also are what the modern art of forestry is concerned with, and those who become interested in this subject on account of its economic or sanitary bearings are very apt to want to know something about the way in which trees grow. To all such persons Prof. Ward's book will be very welcome. In a brief introduction the author describes the general habit of the oak, and then, starting with the acorn, he describes the unfolding of the embryo, the development of the young plant, and the form and functions of the mature tree. There is a chapter on the structure and technological peculiarities of oak timber, followed by another dealing with the cultivation of the oak, and the parasites and fungi which infest it. A number of illustrations are given, showing the appearance of oak wood injured by various fungi. Lastly, the relationships of the oaks receive brief consideration.

The World-energy and its Self-conservation. By William M. Bryant. Chicago: S. C. Griggs & Co. 1890. Pp. 304.

This is a metaphysical inquiry into the fundamental conceptions of the universe. The author holds that the laws of thought are necessarily the laws of things, and takes perfect consistency in consciousness to be the ultimate and absolute ground of all certitude. From this basis he attempts to formulate the universe, and reaches the conclusion that the one permanent reality of which the world we know is a manifestation is spirit. Stated in his own words, the conclusion to which his argument leads is:

"The world-energy is God. Its self-conservation is the eternal process of creation. 'Evolution' is the temporal aspect of this process. The self-unfolding of God culminates in man. For man is the son of God."

Though the author's argument shows wide reading and much acute thinking, he can not be said to have a happy mode of expression, or the power of putting clearly the thought in mind. The reader soon finds himself lost in a maze of contradictions and wandering in a wilderness of words which convey few or no definite ideas. Very little intellectual good would seem to come from discussions of this nature. You begin and end nowhere, with nothing proved or provable. This is not to say that it is not desirable and important to have clearness and definiteness in our fundamental notions of things, but this is hardly to be attained by spinning a logical web out of our inner consciousness, and trying to find its justification in an assumed harmony between the laws of thought and things.

Money, Silver, and Finance. By J. Howard Cowperthwait. New York: G. P. Putnam's Sons. Pp. 242.

The author claims to have tried to answer the silver question by arguments based both upon the truths of financial science and upon the principles which underlie the operation of business. He hopes that in this volume the busy man of affairs may find some scientific points which may hitherto have escaped his attention; the student in finance a portrayal of business ways; and other readers may find their chain of evidence against silver fallacies more firmly made up. He thinks that besides "treating free coinage," sound finance demands a repeal of the present silver law, and nothing less. "Whether it be possible or not to frame a banking and currency act which shall be acceptable where money is scarce and not too objectionable elsewhere, the war against silver theories must be continued until there shall be effectively presented to the strong common sense of the American people the ludicrous spectacle of thousands of men devoting their time and labor to taking silver out of the mines, where it could do no harm, for the purpose of placing it in the Treasury's vaults, whence its monstrous bulk menaces the industries and the general prosperity of the country." In his succeeding chapters the author discusses the evolution of money, trades, and finance; the movements of prices; India and her silver rupee; prices, wages, and labor-saving machinery; the debtor class and foreign exchange; foreign exchange under normal and under abnormal conditions; the views of representative advocates of silver; ultimate redemption; the old volume-of-money theory; the present silver and currency law; international conferences, and bimetallism.

An Introduction to Chemical Theory. By Alexander Scott. New York: Macmillan & Co. Pp. 274. Price, $1.25.

This is a text-book designed to supplement laboratory work, and such books as are mainly confined to the enumeration of facts, by supplying that knowledge of principles and laws which is needed to bind chemical facts together in the mind of the student. The author assumes that users of this book will have a fair knowledge of the chemical properties of substances, and have access to a teacher. "For this reason," it is stated in the preface, "references have frequently been made to matters somewhat outside the subject under discussion, for the purpose of stimulating the more inquiring student, without, at the same time, perplexing those less so. . . . As far as possible, all very debatable matter has been omitted, and it is for this reason, for example, that the account of the theories of solution has been made very short."

The Microscope in Theory and Practice. By Carl Naegeli and S. Schwendener. New York: Macmillan & Co. Pp. 394. Price, $2.60.

One of the most thorough and scientific of treatises on microscopy is here presented in an English dress. The translation comprises the authors' work, Das Mikroskop, except Parts VIII, IX, and X, all copies of which, together with the woodcuts illustrating them, were lost by a fire soon after the sheets were printed. The volume opens with an explanation of the theory of the construction of the several parts of the microscope, embracing calculations of the paths of rays passing through the lenses, determinations of the positions of images, of the optical power of instruments, and various other problems. The division of the work on testing embraces testing the optical power, the spherical and the chromatic aberration, the flatness of the field of view, and the centering. The theory of microscopic observation, or the interpreting of microscopical images, is treated with much thoroughness. Technical microscopy receives due attention, and there are chapters on the simple microscope and the lantern microscope. The volume closes with an account of the phenomena of polarization. Over two hundred figures and diagrams illustrate the text.

Laboratory Manual of Chemistry. By James E. Armstrong and James H. Norton. American Book Company. Pp. 75. Price, 50 cents.

This manual consists of directions for one hundred and sixty-four experiments, accompanied by questions designed to call the attention of pupils to the principles which the experiments reveal. It is designed to be used with Eliot and Storer's Manual of Chemistry, or any other good text-book of elementary chemistry. The course here laid out is designed to occupy a class three hours a week for forty weeks. There are as many blank pages for notes as printed pages in the volume, and thirty cuts showing the forms and use of apparatus are given. The experiments include the tests commonly used in qualitative analysis.

The Plant World. By George Massee. New York: Macmillan & Co. Pp. 222. Price, $1.

The adult who wishes to obtain a general view of the vegetable kingdom will find this book a very competent guide. Its seven chapters deal respectively with plant architecture, chemistry and physics of plant life, protective arrangements, reproduction, relationship, geographical distribution, and fossil plants. The workings of evolution in the vegetable world are made especially prominent in this volume, and the conception of a plant as a living organism is strongly insisted upon. The text is illustrated with fifty-six cuts.

Fossil Botany. By H. Graf zu Solms-Laubach. New York: Macmillan & Co. Pp. 413. Price, $4.50.

In the translator's preface this treatise is described as "the only critical digest as yet published of our present knowledge of fossil plants from the point of view of botanical morphology." It is based upon university lectures delivered by Count Solms-Laubach in Göttingen. The ground covered by this work comprises the thallophytes, archegoniatæ, and gymnosperms, but excluding the angiosperms. There are forty-nine illustrations, and the volume has a bibliography of seventeen pages and an index.

The Jew at Home. Impressions of a Summer and Autumn spent with Him. New York: D. Appleton & Co. Pp. 105.

The author, who professes to have gone to southeastern Europe in the summer of 1891 with no thought of the Jew or his affairs in his head, by some fortune saw him almost daily for five months under all conditions of life, at Brody and Lemburg, in Austrian Poland; at Marámaros Sziget, in Hungary; at Berdicheff and Kiev, in Russia; and at other places, and formed a very poor opinion of him and his manner of living. He describes what he saw, or rather, perhaps, his impressions of what he saw, in very strong language, and illustrates his descriptions with pictures which are, at least, strongly characteristic. The result of the whole is the representation of "The Jew at Home" as an odious and repulsive object, whose habits make him deserving of the scorn that he receives. Grant that this is so—and we have enough representatives among us of that class of Hebrews who are not pleasant associates—the race has in other regions furnished enough high-minded and enterprising citizens, and has distinguished itself sufficiently by liberal and benevolent enterprises, to enable us to know that it is still capable of better things. The author acknowledges this in substance, and in view of the fact and of his acknowledgment, we regret that he could not, while truthfully, as he claims to have done, describing the degradation to which centuries of contumely and maltreatment have reduced certain classes of Jews, have spoken of them in less harsh terms and with more hopefulness of their ultimate redemption under more favoring circumstances. One view he suggests, however, is worth considering, and is of weight proportioned to the degree of truthfulness contained in it: that is, that these Jews are not real, pure Jews, but a mixed race who have preserved of the Jews chiefly their language and the form of their religion. We agree with him in his "last word," which is simply this: "Treat the Jew, if he is brought to you, as an ordinary man; grant him no advantages you would not give his Austrian, Polish, or German fellow-countrymen, no matter what his religion is. Make him an Englishman or an American, break up his old customs, his clannishness, his dirt, and his filth, or he will break you."

Outlines of Theoretical Chemistry. By Lothar Meyer. Translated by P. P. Bedson and W. C. Williams. London and New York: Longmans, Green & Co. Pp. 232. Price, $2.50.

The present volume differs from the author's Modern Theories of Chemistry in being a smaller and less technical treatise. Being addressed not only to the student but also to the friend of science who wishes to keep informed as to the progress of chemical investigation, the book does not contain any great number of the numerical results of observations and measurements, nor any detailed descriptions of experimental methods. It is, therefore, a general review of the subject of chemical philosophy in which details have not been allowed to rise into prominence. The author, of course, needs no introduction or commendation to any one who is acquainted with modern chemistry.

In the *Report of the Commissioner of Education for 1888–'89*, the commissioner, Dr. *William T. Harris*, presents first a general statistical exhibit of education in the United States. From these statistics it appears that the enrollment is about ninety per cent of the number of children between six and sixteen years of age in the whole country, which is as large as could be expected. The South is manifesting a great and increasing interest in public schools, and in the past nineteen years has more than doubled its expenditure *per capita* for education. A prominent feature of this report are the accounts of education in various foreign countries, prepared by specialists of the bureau, and the comparisons with education in the United States for which these accounts furnish material. Dr. Harris calls attention to the fact that the French and German children devote much less time than the American to memorizing the spelling of words. "Mechanical memorizing," he continues, "is the much-lamented characteristic of our common schools. It is evident that such must remain their characteristic so long as English-speaking children memorize, like the Chinese, the arbitrary spelling of more than ten thousand words before they can write the language with readiness." The training of teachers is another subject to which much attention is given, the report embracing papers on The Inception and Progress of the Normal-school Curriculum, The Teaching Force of New England from 1866 to 1888, and Professional Work in the Normal Schools of the United States. Chapters on courses of study in city schools, manual and industrial training, compulsory attendance laws, State text-book laws, and miscellaneous educational questions are included in the first volume of the report. The second volume contains the usual statistics of schools and colleges, and of the education of special classes, and an alphabetical list of the publications of the Bureau of Education from 1867 to 1890.

The *Report of the Smithsonian Institution* for 1889–'90 contains an account of the progress that has been made in establishing the National Zoölogical Park at Washington, together with the usual information about the work of the Institution for the year. Appended to the report are some thirty papers on a wide variety of scientific subjects, a number of them being illustrated.

The Journal of Proceedings and Addresses of the National Educational Association, for 1891, makes a handsome octavo volume of about nine hundred pages. Besides an account of the proceedings of the Association and reports of committees at the Toronto session, the Journal contains the papers read, together with abstracts of the discussions which they called forth. A wide variety of topics in all departments of educational work is treated in these papers.

A booklet which has attracted much attention and been read with interest in religious circles is entitled *Not on Calvary: A Layman's Plea for Mediation in the Temptation in the Wilderness*, and is published by Charles T. Dillingham, New York. It presents a new view of the life and office of Christ while on the earth, which the author hopes may be more acceptable and easier of credit to those who doubt concerning the present accepted view. Not "Calvary"—the crucifixion—according to this view, was the culmination of Christ's life work, and marked the accomplishment of his mission, but the temptation in the wilderness, in which "our Lord literally bought back the spiritual freedom of mankind through the spiritual danger that he, guarded with the weakness of the flesh, was presumed to encounter when he was led by the Spirit into the wilderness."

The *Elements of Economics of Industry*, by *Alfred Marshall*, is an abridgment of the first volume of the author's Principles of Economics, noticed in our June number. The reduction of the larger work has been effected by the omission of many discussions on points of minor importance and of some difficult theoretical investigations, thus allowing arguments that are retained to be given in full. A chapter on trade-unions is included in the present volume, although in the larger work this subject is postponed to a later stage. (Macmillan, $1.)

The results of extended study are embodied in *The English Language and English Grammar*, by *Samuel Ramsey*. The former part of the book is a general account of the origin and present condition of our mother-tongue, considerable attention being devoted to pronunciation and spelling. The latter part is a treatise on the nature and uses of the parts of speech, closing with some suggestions to young writers. Throughout the volume the author gives his personal impressions freely on controverted matters, though acknowledging, as for example in his analysis of the sounds in English speech, that others see these things differently. (Putnam, $3.)

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Quatrefages, A. de. Darwin et ses Précurseurs Français (Darwin and his French Precursors). Paris, France: Félix Alcan. Pp. 273.

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Yatabi, Rijo Kichi. Iconographia Floræ Japonicæ. Descriptions, with Figures, of Plants Indigenous to Japan. Tokyo. Pp. 170, with Plates.

Zoölogical Society of Philadelphia. Twentieth Annual Report. Pp. 21.

POPULAR MISCELLANY.

Anthropology at the World's Fair.—Prof. F. W. Putnam, the distinguished anthropologist of Cambridge, Mass., has outlined a most attractive and important exhibit of anthropology at the World's Fair. The department will occupy the northern half of the gallery of the Main Building and also a strip of land along the lagoon; on this land groups of native American peoples will be living in their natural habitations and surroundings. There will be a representative exhibit of the remains of prehistoric man in America, and large models of the most noteworthy of their works, such as the Serpent Mound and Fort Ancient. Central America will be well represented. Along with this there will be an exhibition of primitive industries, customs, and the like. The section of physical anthropology will illustrate modern methods of recording bodily characteristics, and will show charts recording the results of many thousand measurements. A large body of workers are now engaged in measuring native Americans in all parts of the land. Measurements of children are also being gathered for the study of the development of physical characteristics. This is a large and important undertaking, from which results of great scientific value are sure to come. With this department there is also connected the department of history, so that the exhibit of primitive man and his works is followed by that of the men whom Columbus met, and thus prepares the way for the exhibit of the historical changes in America during the last four centuries. The comprehensive scope of the exhibit is noteworthy, and under the leadership of Prof. Putnam an exhibit creditable to American science is assured.

Experimental Psychology at the World's Fair.—Those who have been interested in the growth of the new psychology will be glad to learn that there will be made at the World's Fair an exhibit of the methods and results of this young science. There will be in operation throughout the six months of the exposition a psychological laboratory in which simple tests will be made of the senses, sense-judgments, rapidity of movements, and simple mental processes, memory, and so on; the data thus accumulated will be statistically utilized to obtain normal standards. There will also be exhibited apparatus employed in psychological research, results obtained, as illustrated by charts, diagrams, photographs, etc.; and as complete a representation of recent psychological activity as the facilities will admit. The department is in charge of Prof. Joseph Jastrow, of the University of Wisconsin, and is a part of the general department of which Prof. F. W. Putnam is chief.

A Portrait of William Bartram.—When the sketch of the Bartrams was published in the April number of the Monthly, we were not able to find any authentic portrait of either of them, or to learn that any existed. The publication of the sketch called out from Dr. W. H. Mills, of Syracuse, N. Y., the information that an engraved portrait of William Bartram was in existence, and formed the frontispiece to the second volume of the Cabinet of Natural History and American Rural Sports, published in Philadelphia in 1832 by J. & T. Dougherty. Through the kindness of Dr. Mills we have been able to procure this volume, and to have a copy made of this picture. Concerning the authenticity of the portrait, the statement is made in the Biographical Sketch of William Bartram, which is the first article in the volume, that "the accompanying portrait is a correct likeness of Mr. Bartram, and the only engraved one ever given to the American public." It will be observed that the date of the publication of this portrait was only nine years after Mr. Bartram's death.

The Schools of New York State.—According to the Report of State Superintendent Draper, while the number of children of school age in the State of New York appeared to be 22,823 less than in 1890, the number of children in attendance on the public schools (1,054,044) was greater by 11,884. Besides these, the private schools reported an attendance of 157,603, and the normal schools, academies, colleges, etc., 69,392 pupils of school age in 1891. Comparative tables of attendance show a steady increase in cities (270,926 to 513,066) since 1861, while the attendance in towns has fallen from 601,928 to 540,978. The superintendent calls attention to the insufficiency of the laws for compulsory attendance, and in view of crude features in the laws of some other States, he recommends the formation of a State Educational Commission, with sufficient powers to consider the whole subject of the school laws of the State. In view of the weakness of some of the school districts, the superintendent favors the consolidation of small and weak districts when it can be brought about without serious inconvenience to the children of school age. It is not to be overlooked, however, that the school must be at a convenient distance. In Massachusetts provision is made for the transportation of children to distant schools, and profitless schools have been abolished, while the children are now instructed for a longer term under teachers of more experience and skill. The superintendent recommends the township system of school organization for consideration. An increasing interest in Arbor Day is noticed. The celebrations are usually marked by appropriate literary exercises, with many ingenious and elaborate programmes. Interest in this work has been stimulated by the offer, by Mr. William A. Wadsworth, of prizes for the best-kept school-grounds. The vote upon the question of a State flower has resulted in a majority for the rose over the golden-rod. The attempt to provide text-books to be published by the State has resulted disastrously wherever it has been made. The superintendent thinks that the result of such a policy would be bad, even if it were seemingly successful. It would discourage authorship, discontinue competition among makers, and stop the constant improvement in the matter, style, and character of the books which has been marked in the past.

Barrel-making.—Few people, says Chambers's Journal, though all are familiar with the barrel, have probably been at pains to consider the skill and ingenuity which have succeeded in bringing to perfection an invention as scientific as beneficial all the world over; and probably fewer still are conversant with the brain-power and time which have been expended in attempts to produce machinery for manufacturing them. Barrels were in use as far back as the time of Pliny, who says they were invented in the Alpine valleys. A cask is a double conoid—that is, it has its greatest diameter or its bulge or belly in the center. The stave is curved lengthwise to form the bulge and crosswise to form part of the circumference of the cask; while the edges must receive the exact bevel to fit those on either side along their entire length. Then the staves have to be "chimed" or beveled at the ends, and furnished with a "croze" or groove, into which to fit the heads; and hooping completes the manufacture of the cask. A new invention, by a Mr. Oncken, is in full operation at Merxem, in Germany, for turning out casks from one piece of wood. In the process the stem of a tree is cut into lengths corresponding to the size of the cask. These lengths are then boiled for two or three hours in a closed vessel, while a current of electricity is passed through the water. The wood is thereby softened so that it can be cut, in a machine rotating the log in the same manner as the ordinary lathe, into a sheet of any desired thickness. The sheets are then passed through a grooving machine and grooved. Another machine seizes the sheet between two arms, and by means of knives cuts a series of mortices or slots around the sides, so as to give them, when made up, the desired conical shape. Eventually the sheet reaches the cooper, who rolls it into cylindrical form, drives on the hoops, and makes a barrel of it.

The Chemung Geological Formation.—The conclusions of Prof. John J. Stephenson's review of the relations of the Chemung and Catskill formations on the eastern side of the Appalachian basin, as expressed in his address at the American Association, are that the series from the beginning of the Portage to the end of the Catskill forms but one period, the Chemung, which should be divided into three epochs—the Portage, the Chemung, and the Catskill; that the deposits of the Catskill epoch were not made in a closed sea or in fresh-water lakes; that the disappearance of animal life over so great a part of the area toward the close of the period was due to gradual extension of the conditions existing in southeastern New York as early, perhaps, as the Hamilton period; and that the Chemung period should be retained in the Devonian.

Scenery of the Mustagh Glaciers.—In his description, before the English Society of Arts, of the Pamirs and neighboring regions, Captain F. E. Younghusband gave a picturesque account of the scenery of the glacial regions of the Mustagh Mountains. The first object to attract attention in ascending the mountain streams is the appearance of what seem to be great heaps of gravel, with a stream issuing from their feet. Clambering up to the summit of one of these mounds, the traveler looks upward over a sea of needle-like pinnacles of ice, of every fantastic shape and variety of color, and among them sees long lines of rocky *débris*, the medial moraines of the glacier, "while on either hand mountains of stupendous height rise in stern and solemn glory." Among the pinnacles, or *serecs* of ice, "may be seen fairy-like caves and grottoes of pure ice, with icicles twenty or thirty feet in length hanging from the ceiling or formed in a delicate fringe across the entrance, and into the walls of these lovely caves one can look as into a sheet of glass." When the great snow-fields at the head of the glacier are reached, "all is white, pure, and unblemished; and the bold intruder is deeply and unforgetably impressed with the noble sublimity of the mountains towering round on every hand, and moved by his audacity in daring to intrude into regions ruled by Nature in such stern and silent grandeur. He feels, too, what tremendous forces are at work beneath the calm and placid surface; for, while at first sight all seems still and unchangeable, a glance around shows the glaciers rent into great chasms with perpendicular walls of ice, perhaps hundreds of feet deep, into which, if a stone is dropped, it bounds from side to side, and the echoes are heard coming up from the very heart of the glacier. And then a little observation shows that these vast seas of ice, motionless and immovable as they seem, are year by year forcing their way down the valleys, carrying on their icy bosoms the fragments and craigs of rock which have been broken off from the mountains by the nipping fingers of the frost. Great cliffs, too, are met with, worn away and ground by the glacier forced against them; and I have seen a whole cliff of limestone polished and smoothed by the glacier almost as well as small fragments of rock are by the hand of man."

Eastern and Western Weeds.—A comparative list has been published by Prof. Byron D. Halsted, made up from his own observations and those of his correspondents, of the weeds of New Jersey or the East, and Iowa or the central West. Of 297 weeds in Iowa, 210 are native and 87 are foreign; and they are further classified as 51 worst weeds, 94 bad weeds, and 152 indifferent weeds. In passing from the worst weeds through the middle class to the indifferent, the percentage of perennials rapidly increases. In New Jersey, 135 weeds are native and 130 are foreign; and 55 are worst, 98 are bad, and 112 are indifferent. The weeds in Iowa not found in New Jersey are mostly of the indifferent class, native in large part of the prairie, and as a rule quickly disappear when the land is placed under cultivation. The New Jersey list can be made up from the one for Iowa by omitting 75 of the native prairie plants, mostly perennials, and adding 43, a large percentage of which are annuals. The only single weed of the first rank stricken from the Iowa list in adapting it for New Jersey is a species of pigweed, but even this has within a year been found in New Jersey. On the other hand, there are several first-class (worst) weeds that are added in the adaptation of the Western list to the East. Of such, for example, are a pepper-grass, the wild radish, two kinds of cocklebur, feverfew, wild onion, wild leek, nut-grass, Bermuda grass, and a kind of chess. The East is overrun with a larger number than the West of the most aggressive weeds—"weeds that assert their ability to resist the forces of the cultivator and plant their banners upon the tilled ground, likewise annual weeds that stock the soil with a multitude of seeds, ready to spring into life whenever an opportunity offers. Some species of weeds, such as a goose-foot, a pigweed, a thistle, plantain, shepherd's-purse, and purslane, are found everywhere from Maine to California; others are prominent on the Pacific coast and not elsewhere; and there are weeds peculiar to the Rocky Mountain region, and others to the prairie region. In the middle prairie States it is mostly the members of the sunflower family that prevail. In the central States the list is led by the Canada thistle, quack-grass, docks, daisy, chess, plantain, and purslane. If to this list we add wild carrot, onion, and parsnip, and the like old foreign enemies, we have the extensive catalogue of these plant pests that prey upon the lands of New England.

Hypnotism as a Remedy.—Accounts are given by Dr. George C. Kingsbury, in his Practice of Hypnotic Suggestion, of fifty cases of pain or disease which he has himself treated by hypnotism. In forty-five of these, complete cure followed, without any relapse so far as is known, and there was at least some slight or temporary relief in the five others. In one case the hypnotism was used as an anæsthetic in childbirth. The patient was hypnotized twelve times in preparation for her confinement, and once more when it began. She was brought to the convenient stage of hypnotic somnambulism in which she could understand and obey orders and nevertheless felt no pain. In the treatment of three patients of confirmed drunken habits some remarkable results in the way of sobriety, or even dislike for alcohol, were obtained, which had lasted up to the time of the publication of the book, nine months or more, and none of them was known to have relapsed. In many lesser ills, such as neuralgia, headache, toothache, etc., the relief of the pain was immediate and complete. The author has found no damage done by hypnotism in careful hands.

The Weather and Influenza.—A paper by Dr. Lang, of Munich, treats of the relations between influenza and changes of weather. Among atmospheric conditions favorable to the development of infectious maladies are light and rare precipitations, while the soil dries out and dust abounds, and next slight winds. Such conditions prevail in anti-cyclones. But not every barometric maximum that occurs can be accused of being a promoter of an epidemic. The germs of the disease must be present, then the anti-cyclone is a danger. Entirely local conditions can not be held to account for what passes in the atmosphere, nor for events that depend on its constitution, for the air is not, like us, fixed to the ground. It is continually suffering displacement, and brings us elements from all the places over which it has passed. We must look, therefore, to the place where the wind started—that is, to the center of the aërial circulation of the region in which we are. We know that the distribution of barometric pressure is a determining cause of the movements of the air, and it may be that the corpuscles scattered through the atmosphere have been brought from far-off regions, especially if the distribution of the pressure has continued the same during a considerable time. In the winter of 1889–'90 a barometric maximum was fixed for six weeks in the eastern part of Europe, with only unimportant modifications in its shape and extent. Now, since the East included the starting-point of the epidemic of influenza that prevailed then, it is presumed that this atmospheric condition favored its extension toward the West. The views expressed by M. Masson, of Paris, before one of the medical societies of that city, substantially agree with these. The period of greatest mortality from grip in Paris, from November, 1889, to February 1, 1890, was marked by a constantly higher pressure than the average; the temperature did not fall below 5° C.; the hygrometric condition was high, and radiation fell off from the very beginning of the epidemic. In the principal capitals of Europe, according to M. Masson's investigations, the grip coincided in general with a humid, foggy condition of the atmosphere, and only moderate cold and an unusual height of barometer. It was so at Vienna, Berlin, and Brussels. But in Russia, where the grip is endemic, the mortality increased when the barometer fell and the thermometer rose, and the mean humidity was augmented. At St. Petersburg it disappeared when the pressure rose and the cold became more intense. For all other regions M. Lang's and M. Masson's rules were verified.

The Parapee Palm.—According to a note in Garden and Forest, the Parapee palm (*Guilielma speciosa*) is cultivated by the Indian aborigines of the Guianas for its fruit, which they use largely as food. They plant it about their settlements, and, where it is found apparently wild in the forests, examination will show that such situations were formerly occupied by the Indians. In some seasons the fruit is produced without seed, while in other seasons it contains seeds, the variation occurring in the fruit of the same trees from season to season. When boiled or roasted the fruit has something of the texture and taste of a dry, mealy potato. It is palatable and very nutritious. The fruits, which are individually about the size of a pigeon's egg, are borne in bunches of from forty to sixty together. There are two or three bearing seasons in a year.

Preservation of Minerals and Fossils.—Minerals and fossils are not exposed to the ravages of insects, like zoölogical collections; but many of them are liable to destruction by deliquescence and efflorescence. Deliquescence is the property possessed by some bodies of attracting moisture from the atmosphere and dissolving in it. There is no means of preventing these accidents, except inclosing the specimens in hermetically sealed envelopes. Efflorescence is a property possessed by other bodies of falling into powder. There are several ways of protecting specimens against it. Fossils converted into white pyrites, or the substance of which is impregnated with salts and not susceptible of being washed, should be fully dried and covered with a varnish that will not scale, and they can also be dipped in oil. Impressions in danger of being rubbed off can be consolidated by impregnating them with a thin solution of gum arabic, a little sugared to prevent its cracking. Mr. Chalande recommends for the preservation of rocks, fossils, bones, etc., liable to split or fall into efflorescence, placing them for from one to twenty-four hours, as the case may demand, in a bath, made by mixing equal parts of silicate of soda or potash and water, and drying after the bath. This gives the piece a considerable degree of hardness. For the preservation of pyritous fossils, M. André Fonville recommends preservation in paraffine; this, however, is only adapted to small specimens; and for fossils of considerable size, like ferns, sigillaria, etc., he advises the silicate-of-soda method. To consolidate fossil bones, M. Lambert recommends coating with boiling melted whalebone. The hot matter penetrates the pores and becomes very hard. If any of it remains on the outside of the specimen, it may be removed with blazing paper. Gelatine and strong glue, used by many persons, are good, but not so good as the whalebone application.

The "Silver Thaw."—The "silver thaw," as described by R. C. Mossman, of Ben Nevis Observatory, occurs during an inversion of ordinary temperature conditions, when the temperature is considerably lower at the surface than at higher altitudes, and the rain congeals as it falls. In the six years from 1885 to 1890, 198 cases of silver thaw were observed at Ben Nevis, with a mean duration of four hours and a half in each case. They nearly all occurred between November and March, during times of perfectly developed cyclones and anti-cyclones. Ninety per cent of the cases occurred when the thermometer was between 28° and 31·9°, so that the greater number of cases occurred just before a thaw. The most common type of cloud which preceded both cyclonic and anti-cyclonic cases of silver thaw was cirro-cumulus, frequently accompanied by cirrus and cirro-stratus; and the changes showed that the higher strata of the atmosphere came first under the influence of the moist current, which took from three to eight hours to descend to the height at which cumulo-stratus forms.

Our Destructive Locusts.—Eight kinds of destructive locusts are described in Prof. C. V. Riley's paper on that subject as infesting the United States or parts of its territory. The first is the Rocky Mountain locust (*Caloptenus spretus*), which has caused great destruction at times in its sudden, temporary appearances in the Western States and Territories. Its permanent breeding-ground, where it breeds every year and is always to be found in greater or less numbers, embraces the larger part of Montana, a narrow strip of western Dakota, all but the northwestern quarter of Wyoming, the central and northwestern parts of Colorado, small tracts in Utah, Oregon, and Idaho, and a large area in the British possessions north of Montana. The subpermanent region, where it is liable to breed for a few years and then disappear, lies immediately east of this; and the temporary region, where it appears for single seasons, includes large territories east and south of the subpermanent region. The lesser migratory locust (*Caloptenus atlantis*) breeds annually in abundance from middle Florida nearly to the Arctic Circle. It has been marked as injurious in New England in nineteen seasons since 1743. The non-migratory red-legged locust (*Caloptenus femur rubrum*) has a common range with the previous species, but is rarer in the eastern part of its range, while it becomes abundant in the Mississippi Valley. It causes only local damage, and few cases of destructive appearance have been recorded. In common with the differential and two-striped locusts, it often gives cause for alarm by devastating grass-lands or growing crops. The California devastating locust (*Caloptenus devastator*) is a Pacific species, of which fifteen local destructive visitations are recorded. The differential locust (*Caloptenus differentialis*) ranges through Illinois, Missouri, Nebraska, Kansas, and Iowa, and is found in Indiana, New Mexico, and California. Though not migratory, it is capable of making considerable flights, and is sometimes locally destructive. The two-striped locust (*Caloptenus bivittatus*) has an extensive range, covering most of the country. It is distinguished by its two lateral stripes reaching from the head to the extremities of the wing-covers. It often becomes locally abundant enough to do much damage to crops. The pellucid locust (*Camnula pellucida*) occurs in the far West and in Maine, Massachusetts, Vermont, and Connecticut. The Eastern and Western forms used to be considered two species, but the difference between them is not appreciable. The American Acridium (*Schistocerca americana*) is our largest locust, being more than two inches and a half long. It occurs throughout the Southern States, through Mexico into Central America, and as far north as Illinois and Indiana. It is sedentary within the bounds of the United States, and becomes only locally destructive. Farther south, it is said to possess the migratory habit.

Objects of Forest Management.—Forest management, says Prof. B. F. Fernow, in his excellent paper on What is Forestry? has two objects in view, of which the first is to produce and reproduce a certain useful material, and the second to sustain or possibly improve certain advantageous natural conditions. In the first case we treat the forest as a crop which we harvest from the soil, taking care to devote the land to repeated reproduction of crops. In the second case we add to the first conception of the forest as a crop another, namely, that of a cover to the soil, which, under certain conditions and in certain locations, bears a very important relation to other conditions of life. The favorable influence which the forest growth exerts in preventing the washing of the soil and in retarding the torrential flow of water, and also in checking the winds and thereby reducing rapid evaporation—further, in facilitating subterranean drainage and influencing climatic conditions, on account of which it is desirable to preserve certain parts of the natural forest growth and extend it elsewhere—this favorable influence is due to the dense cover of foliage mainly, and to the mechanical obstruction which the trunks and litter of the forest floor offer. Any kind of tree growth would answer this purpose, and all the forest management necessary would be simply to abstain from interference and leave the ground to Nature's kindly action. This was about the idea of the first advocates of forest protection in this country. But would it be rational and would it be necessary to withdraw a large territory from human use in order to secure this beneficial influence? It would be, indeed, in many localities, if the advantage of keeping it under forest could not be secured simultaneously with the employment of the soil for useful production; but rational forest management secures the advantages both of favorable forest conditions and of the reproduction of useful material. Not only is the rational cutting of the forest not antagonistic to favorable forest conditions, but in skillful hands the latter can be improved by the judicious use of the axe. In fact, the demands of forest preservation on the mountains, and the methods of forest management for profit in such localities, are more or less harmonious; thus, the absolute clearing of the forest on steep hill-sides, which is apt to lead to desiccation and washing of the soil, is equally detrimental to a profitable forest management, necessitating, as it does, replanting under difficulties. Forest preservation, then, does not, as seems to be imagined by many, exclude proper forest utilization, but, on the contrary, these may well go hand in hand, preserving forest conditions while securing valuable material; the first requirement only modifies the manner in which the second is satisfied.

The Zebra's Stripes.—It has been shown by several authors that the stripes of the zebra are a means of protection to it in the forests, by producing light effects like those of the limbs of the bushes by which it is surrounded. One can readily see, says a correspondent of Nature, how the shadows of the branches in a tropical forest, falling upon the zebras, would so intermingle with the stripes of the animals as to add enormously to the difficulties of recognition by human eyes, and also by the eyes of their animal foes. This correspondent believes that the stripes have a still deeper meaning and value. At night, when the animal is lying down partly on its side and partly on its belly, and doubles up its legs, the horizontal stripes on them run in the same general direction with the vertical ones of the body and seem to be continuations of them; or, if it rests on its side and stretches out its limbs, the vertical, diagonal, and horizontal stripes would then be more horizontal than anything else, but pointing in different directions, and would so assimilate themselves with the crossed and varying directions of the shadows as to have the same practical effect in hiding the sleeping animal from its foes.

An Ancient Japanese Burial Custom.—Prof. Hitchcock, of the Smithsonian Institution, calling attention, in a paper on Ancient Tombs and Burial Mounds of Japan, to some small clay figures representing human beings, said it was an ancient custom in Japan to bury the retainers of a prince standing upright around his grave. The compassion of the Emperor Suisina (97–30 B. C.) was aroused by the sufferings of the persons who were thus treated when his younger brother died, and he desired to change the custom. When the empress died, the plan was proposed of substituting clay figures of men and horses for the living victims. From the publication of an edict in the year 646 forbidding the burial of living persons, and also the burial of gold, silver brocade, diaper, or any kind of variegated thing, it is inferred that the custom of living burial was kept up to some extent till the seventh century. Specimens of the figures, called *tsuchi ningio*, introduced to take the places of the living sacrifices, are now very rare, and this fact leads to the supposition that the figures were not buried, but were left exposed on the surface of the ground.

The Lung-fish.—The *Ceratodus* or lung-fish of Queensland, according to Prof. Spencer's account of it in the Australasian Association, lives only in the Burnett and Mary Rivers, in Queensland, and belongs to a small group which may be regarded as intermediate between the fishes and the amphibia.

The swimming bladder of ordinary fishes has been modified so that it serves as a lung. In Africa, *Protopterus*, a form closely allied to *Ceratodus*, makes for itself a cocoon of mud, in which, during the hot, dry season, it lives, and can breathe by means of its lung. The *Ceratodus* does not appear to do this, and probably never leaves the water. It comes continually to the surface, and passes out and takes in air, making a faint spouting noise. The author suggested that the lung was of the greatest service to the animal, not during the hot but during the wet season, when the rivers are flooded and the water is thick with sand. The *Ceratodus* appears to be herbivorous, and feeds largely on the seeds of gum trees which fall into the water.

Dealing with Contagions.—A report by Dr. A. Jacobi calls attention to some peculiar difficulties in dealing with the contagion of scarlet fever and diphtheria. No general hospital must admit patients suffering from either disease. Hotel-keepers are not willing to admit them; but if cases get lodgment within their houses, it is to their interest to conceal the fact. Their interest, however, does not go so far as to induce them to destroy or disinfect curtains and carpets, and purify the walls of rooms, and the contagion is perpetuated. Rooms and suites of rooms in large and expensive hotels are known in which cases of diphtheria have occurred for several years in succession, all provoked by the same germ, lodged in the same curtains and carpets. The same danger lurks in private houses, where the well members are imperiled by the presence of the sick one, and all the surroundings are liable to be infected; and in tenement-houses, where close contact of the well with the sick can hardly be avoided. Patients should be removed from homes and hotels and isolated; but this is impossible, for the want of provision for the proper care of such cases. The only institution for these diseases in New York is the Willard Parker Hospital, which is in a remote part of the city, and has beds for only seventy patients, while twenty-five hundred persons die annually of the infections. Plans for new hospitals are proposed by the Medical Society of the City of New York, and with them stations or refuges, where the children of families in which diphtheria or scarlet fever is prevailing can be housed until the patients at home have recovered or been removed, and their residences, bedding, and furniture have been thoroughly disinfected.

Treatment of Potato Disease.—The treatment of potato disease with sulphate of copper has been found efficacious at Nantes, France. A dressing of three pounds of sulphate of copper to twenty gallons of water, or of two pounds of sulphate of copper and four pounds of lime to twenty-five gallons of water, is used. The best results are obtained by using whole potatoes, sound, of medium size, selecting those which show the finest germs, and cutting very large ones in two. Before planting they are steeped for twenty-four hours in a bath composed of six pounds each of sulphate of ammonia and nitrate of potash and twenty-five gallons of water; then allowed to stand twenty-four hours to give the sprouts time to swell—whereby the growth is quickened and the return is increased. Disease in tubers is arrested by dipping them in a bath of water and as much lime as it will take, and drying them. The diseased part seems to solidify after this treatment, and does not spread, while the good part continues sound.

Propagation of Fine Flower Seeds.—From an address by Mr. George F. Daniels, quoted in Garden and Forest from the Journal of Horticulture, we learn that the increased demand for flowers in England and America has given a corresponding impetus to seed-growing abroad, where they have the advantage of cheap labor and a climate especially adapted to the work. The secret of successful cultivation in Germany lies in the bright, dry autumn, which enables seeds to stand longer and become more thoroughly ripened. The soil is also well adapted for the purpose. Stocks are one of the most expensive crops, in the item of labor, because the finer varieties have to be grown in pots, and they require attention in watering. China asters are grown by acres, one firm devoting more than a hundred acres to them. Petunias require much attention, as each bloom has to be fertilized by hand to insure the setting of the seed. The pollen from the double blooms is very difficult to obtain, the flowers being so dense that they have often to be removed from the plant, then placed in wet sand and pulled open, so as to allow the sun and the air to ripen the pollen, which is carefully removed and placed on the finest single blooms. Calceolarias are shy seeders, and the most careful hybridization is necessary to insure a crop. Every bloom is examined, and the pollen is taken from the stamens and placed on the pistil. As the operation must be performed when the pollen is quite ripe, the flowers must be looked through nearly every day to catch each bloom as it comes to maturity. Seed is very difficult to obtain from carnations, and then only in small quantities. The commoner kinds of annuals are grown in masses. The plan of improving stocks of seed is as follows: As soon as the plants are fully in bloom they are carefully examined, and the best and truest in color or shape are marked by placing a stick next to them. When the seed is ripe they are carefully gathered by themselves, and kept for stock the following year. This is very necessary in case of some annuals, which show a great tendency to revert to the wild state; at the same time it improves the stocks from year to year.

Aluminum in Food-vessels.—Opinions still differ with regard to the value of aluminum for use in food-containing vessels. Messrs. Lübbert and Roscher asserted several months ago, in a paper on the subject, that aluminum was too readily acted upon by food-substances or other substances used in cooking, for its application in the construction of kitchen utensils to be safe. Prof. Lunge afterward instituted experiments on the subject, from which he concluded that coffee, tea, and beer had practically no action on aluminum, and the action of brandy was very slight; while that of acids and acid liquids (wine, sour milk, and fruit juices) was more pronounced, but still too slight to cause alarm. Taking the worst case, that of acetic acid, this author found a maximum attack of five milligrammes per one hundred square centimetres in six days; so that a given vessel, kept always full, would be reduced to half its original weight in fifty-five years. This, he holds, is too trifling an action to be considered. There is no danger of any injurious action upon the human body by aluminum compounds, which, moreover, are not poisonous as compounds of arsenic, mercury, lead, and copper are poisonous. Before they can act injuriously, a quantity will have to be ingested a hundred times larger than he found to be regularly entering the stomach in this way. Finally, he adds, aluminum may be employed without fear for canteens or any other vessels used to hold food, at least at ordinary temperatures. Against these conclusions is a report on the authority of the telegraph of a soldier near Nuremberg, Germany, who was taken sick after drinking cognac from his aluminum flask. On analysis of the brandy it was found to be muddy, and to contain roundish, black particles, which proved to be aluminum and iron. But in this case we had not simple corrosion of aluminum by brandy, but galvanic action of the liquor, aluminum, and iron, with resultant corrosion. Further investigation of the subject is needed.

Photography in Colors.—M. G. Lippaman announces that he has perfected a method of photographing in colors which he mentioned to the French Academy of Sciences fourteen months ago, and has exhibited very brilliant spectra which he obtained without the interposition of the colored screen. The author claims to have obtained the compound colors of natural objects as well as the natural colors of the spectrum. He exhibits a series of plates representing a window of four colors—yellow, green, blue, and red; a trophy of French and other flags; a plate of oranges with a red poppy on top; and a many-colored parrot. The window and the parrot are of dazzling brilliancy. They were photographed with the electric light in ten minutes. M. Lippaman admits that the plates require in practice too long an exposure, and that it will be necessary to make them more sensitive.

Influence of Natural Surroundings on Human Character.—Captain F. E. Younghusband makes a remark in one of his accounts of central Asiatic exploration, on the influence of the natural surroundings on the character of the people of a country. "It has been my fortune," he says, "to travel in very varied descriptions of country—in the dense, gloomy forests of Manchuria; over the bounding grassy steppes of Mongolia; across the desolate wastes of the Desert of Gobi;

and among the mountain valleys of the Himalayas and the Hindu Kush. Each different type of country produced its own peculiar impression upon me, and has enabled me to appreciate perhaps more keenly than I otherwise should have done its particular influence upon the inhabitants. The forest produces a feeling of indefinable repression; one seems so hedged in and hampered about, and longs to be free of the endless succession of trunks of trees, and to be able to see clear space in front. Far preferable, in my opinion, is the desolation of the desert, which, depressing as it may be, in some way produces also a feeling of freedom; and on the open steppes an irresistible desire to roam and wander seems to come over one, which I can well understand was the motive power which caused the Mongol hordes under Genghis Khan to overrun the rest of Asia, and part even of Europe. Again, with these Mongols of the desert and the steppes a stranger is always hospitably received, and there is little of that dread of people from the outside so frequently met with among barbarous nations. The Kirghiz of the open Pamirs, too, have some of these characteristics. But directly one enters the narrow, shut-in valleys, such as are found on the southern slopes of the Hindu Kush and the Himalayas, one finds the ideas of the people shut in too. They have a dread of strangers; they desire, above all things, to be left to themselves, and unless forced by over-population to do so, or led away by the ambitions of a chief, seldom leave the particular valley to which they belong."

Ratios of Illegitimacy.—A table of statistics of illegitimacy in Europe, published by Dr. Albert Leffingwell, shows the Irish to be the most virtuous of all the peoples, the ratio of illegitimate births among them being twenty-six in every thousand. The English rate is forty-eight, and the Scotch eighty-two per thousand. Thus we may roughly say that for every child born out of wedlock in Ireland two are born in England and three in Scotland. In Europe at large, Ireland is closely followed in its place of honor by Russia, with the low rate of twenty-eight per thousand, and by Holland with the rate of thirty-two per thousand. The Italian and French rates are respectively seventy-four and eighty-two per thousand, comparable with the rate in Scotland. Among the countries that show the highest proportions of illegitimacy are Sweden, Saxony, Bavaria, and Austria, in which the rates range from one hundred to one hundred and forty per thousand. Austria is at the opposite pole from Ireland, and takes the lowest place in morality among the European nations, with a rate of one hundred and forty-six per thousand. The inquiry into the causes of these varying rates of illegitimacy raises complicated and interesting problems. The causes generally supposed to be principal factors in the matter are poverty, ignorance, and the contamination of great cities. Examining the influence of these, Dr. Leffingwell finds it very slight. In Ireland, the lowest rates are in the poorest counties. Russia, with one of the lowest rates, is one of the poorest countries; and the author affirms that "there is nowhere such uniform relation between the indigence of a people and the prevalence of illegitimacy as to justify the hypothesis that this phase of moral delinquency in any district or country can be accurately described as caused by its poverty. As little can the influence of great cities account for the prevalence of illegitimacy. Education and creed appear to have little influence. We must seek the real factors in race and heredity, legislative restraints upon marriage, social usage, and other like circumstances."

Value of the Applications of Anthropology.—In a paper on Anthropology as a Science and as a Branch of University Education, Dr. D. G. Brinton thus estimates the value of the applications of this science: "In government and law, in education and religion, men have hitherto been dealt with according to traditional beliefs or *a priori* theories of what they may or ought to be. When we learn through scientific research what they really are, we shall then, and then only, have a solid foundation on which to build the social, ethical, and political structures of the future. It is the appreciation of this which has given the extraordinary impetus to the study of sociology—a branch of anthropology—within the last decade. Anthropology alone furnishes the key and clew to history. This also is meeting recognition. No longer are the best histories mainly chronicles of kings and wars, but records of the development and the decline of peoples; and what constitutes 'a people,' and shapes its destiny, is the very business of ethnology to explain. So likewise in hygiene and medicine, in ethics and religion, in language and arts, in painting, architecture, sculpture, and music, the full import and often unconscious intention of human activity can only be understood, and directed in the most productive channels, by such a careful historical and physical analysis as anthropology aims to present."

Science Teaching in Preparatory Schools.—The report of the Committee of the American Society of Naturalists on Science Teaching in the Schools embraces the answers from the colleges and preparatory schools in the North Atlantic States between Maine and the District of Columbia, to a circular of questions respecting what they require of scientific instruction. Of sixty-nine colleges from which answers were received, only eighteen require science for admission to the course for the degree of Bachelor of Arts. Eleven other colleges require science for admission to the scientific course, while forty colleges offer no recognition of the place of science in the pre-collegiate course. Of twenty-one institutions catalogued as scientific schools, ten do and eleven do not require some science for admission. Of one hundred and forty-one preparatory schools, ninety-eight include science in the course preparatory for the classical course in colleges. These facts seem to indicate that the academies and high schools are in advance of the colleges in the recognition of the claims of science. The report, analyzing the courses of instruction of the schools, shows that the plea that time can not be found for scientific study in the four years of preparatory school instruction is not well founded. The greatest difficulty in securing the right kind of scientific instruction in the schools arises from the lack of properly trained teachers. This difficulty is vanishing, and the number of teachers is increasing who possess an acquaintance with science which, though limited in scope, is in considerable part sound in method. "Let it be clearly recognized that the teacher of science demanded even in the primary schools is not one who has committed to memory some verbal propositions about science, but one who has learned to observe and experiment, to compare and reason, and the conditions are already in existence which will not fail to supply that demand."

Miss North and her Animals.—Miss Marianne North, a British naturalist and traveler, whose death we noticed several months ago, exhibits in her recently published "Recollections" a happy appreciation of the individual eccentricities of animals. A favorite dog of her father's, which was implicitly trusted, when left one day in a room with a tempting pigeon pie, could not resist stealing a pigeon, but replaced the bird with the blackened sponge which Mr. North used to wipe his pens. Miss North made friends with the sacred baboons in the Indian temples, "who came and sat by her side to criticise her drawing, or who, after breaking out in the tricks of their unregenerated monkey nature, would suddenly fold their arms and relapse into pious imbecility, as if they had been disciples of Buddha, and were meditating on the Nirvana. She commemorates her first impressions of the Queensland kangaroos, when she saw fifty come hopping down hill in single file, ludicrously manœuvring as if moved by machinery, and using their big tails for balancing rods. Shortly afterward she saw a bear taking a siesta in the fork of a tree, who merely cocked his great ears and yawned when her attendants shied stones at him. He knew he was out of harm's way. He took his constitutional only at night, and was not going to alter his habits to please anybody. She tells a capital story of a cockatoo, brought up in a zoölogical garden, and taught to say: 'Walk in, ladies and gentlemen; don't all come at once—one at a time.' The bird escaped, and was found with a troop of wild cockatoos attacking it. It was lying on its back, fighting beak and claw, and screaming out: 'Come on, ladies and gentlemen, come on; not all at once, one at a time.' She heard of a South African baboon, who, having taken to brigandage, had assailed a musician returning from a dance, and captured his accordeon. Examining his prize, there was a dismal discord, followed by a hideous howl, and the robber vanished in a panic, leaving the booty behind. She encumbered herself with a family of opossum mice, and this cost her endless trouble and anxiety." But these mice proved extremely serviceable in her journey across the North American continent, for they excited such intense interest with railway guards, hotel-keepers, etc., that they always insured their mistress civility or a cordial reception.

Wild Plants as Fungus-nurseries.—Prof. B. D. Halsted shows, in a paper on fungi common to wild and cultivated plants, that in many cases diseases are transmitted by spores from one genus or family as well as from one species to another. A bacterium that affects the tomato and potato causes a disastrous form of blight in melons, cucumbers, and squashes. The apple rust that yellows the foliage of the orchard in July is identical with the *gynosporangium* that produces the galls, swelling out to large size in rainy weather, on cedar trees, and the spores are transmitted in alternation from one tree to the other. It is thus shown by many examples that the evil influences of plant funguses may act at long range. The lesson may be learned from the experiments that "if so much of the smut, rust, mildew, mold, rot, and blight of our cultivated plants is propagated by the wild plants hard by, it may be wise for every crop-grower to pay attention to what is thriving outside of his garden wall."

Skill of Prehistoric Lapidaries.—The most superficial examination of any fairly large collection of stone implements, says Mr. Joseph D. McGuire, in a paper on the materials, apparatus, and processes of the aboriginal lapidary, is calculated to convince the observer that man in his lowest stage of development was well acquainted with the methods of fracture of various stones, and also that he was a most skillful workman. The articles found in burial-places, in caves, and shell-heaps, as well as surface finds, furnish conclusive evidence that man often carried material many hundreds of miles for the purpose of fashioning, at his leisure, objects of personal adornment or domestic utility as well as weapons. The evidence of progress in the manufacture of tools made by man is easy to find: "From the splinter of bone or piece of stone used in the hand to the diamond drill of to-day is an immense advance, but it can be traced, step by step, without a break. The author has himself experimented on the manufacture of stone implements, using tools similar to those of the North American Indians, and beginning with the raw material. The principal work done was the pecking of stone with the stone hammer, and the carving, polishing, rubbing, and boring of stone with the rudest appliances. The result of the experiments goes far to prove that the time required for the manufacture of stone implements by primitive man was very short." If the time occupied by the writer was short, it is fair to conclude that a skillful workman, using the materials which long experience had taught him were the best for his purpose, would accomplish the task in much shorter time. The author, in his paper, records his experiments in pecking nephrite, kersantite, catlinite, obsidian, and basalt, with different hammering material, in drilling and boring, and in hammering copper, the results of which all went to confirm the view he has expressed.

Extermination of Species.—Some of the more obvious causes of the extermination of animals now going on, says Mr. Frederic A. Lucas, in his paper on that subject in the United States National Museum, are to be found in the systematic killing of animals for their various products, the destruction caused by domesticated animals introduced into new countries, and the bringing of wild land under cultivation. These causes most directly affect the larger animals, while smaller creatures are influenced by slighter ones. The erection of telegraph wires has proved destructive to birds, while other birds meet their fate by dashing against the electric lights. The extinction of the rhytina and the great auk, the almost complete extirpation of the bison, and the reduced numbers of the walrus, are good examples of destruction wrought directly by the hand of man; and, besides, there are the still more numerous instances of the very perceptible decrease of animals once abundant. Species used for food, or otherwise of economic value, suffer most; fashion affects some, some are necessarily destroyed for the protection of man and his domesticated animals, and others are killed merely for sport. The passenger pigeons, formerly visiting us by millions, are now unknown in places where they once abounded. Halibut, lobsters, and oysters are getting scarce, and the Atlantic salmon and shad are practically kept from extermination by the efforts of fish commissions. One reason for this growing depletion of animals is found in the fallacy that, because some animals exist in large numbers, the supply is unlimited and the species needs no protection, which is indulged in till the species is on the verge of extermination. Usually, too, those most directly interested in the preservation of game are the bitterest opponents of protective measures, especially if the change will produce even temporary inconvenience. Although regret at the impending or actual extermination of a species is often purely a matter of sentiment, there is no lack of instances where the strictest utilitarian is quite as much interested as the naturalist in preserving a species from destruction. The pity of it is that in so many cases a small amount of protection would not only preserve for the naturalist the animals he wishes to study, but furnish the practical man with an additional source of wealth.

Concerning Overwork.—In treating the question whether laborious occupations in themselves may lead to premature strain of the body or mind, and so to degeneration or disease, Dr. P. H. Pye-Smith thinks we "must distinguish." Aneurism, emphysema, and some forms of cardiac hypertrophy may be the result of overstrained and too violent and prolonged exertion, from mechanical stretching of the great arteries by movements of the arms, from high blood-pressure, excessive calls on the heart, and over-long suspension of respiration, as in muscular efforts with a closed glottis. "We see similar results in horses which are put to too hard work at too early an age, and there is no reason to doubt the operation of such causes of disease in man. But their operation is limited to the production of certain definite lesions, and there is no evidence that harm is done, disease brought on, or life shortened by what is commonly known as work, whether mental, physical, or a combination of the two. The vanity of human nature is tickled by ascribing its disorders to such respectable antecedents as industry, energy, and intellectual activity. We must all have felt this when the results of habitual idleness or gluttony are ascribed by a patient or his wife to an overtaxed brain or too strenuous devotion to business—especially in the public service. There is no fear of any one of us" (members of the Royal College of Physicians) "using our brains too much for our health, nor do I believe that mental labor or honest work of any kind interferes with health or shortens life a day. Even if it did, who would not rather be worn in use than rust in idleness? Who would not choose a short-spanned life, filled full of action and of thought, of sorrow and of joy, of effort and of endurance, of enjoyment of living one's self and helpful service to others, rather than to wear out a tedious existence of monotonous ease?"

Agriculture in Egypt.—The land of Egypt was irrigated in ancient times by turning the red water from the Nile at high flood into the basins into which the country was divided by the construction of earth-banks at convenient distances. The water was allowed to stand at a depth of three feet or more for forty or sixty days, till the earth had become saturated and the weeds had been killed, and the fertilizing layer of finely divided red mud had been deposited on the soil. The water being drawn off into the receding river, the seed was sown upon the soft mud. Sometimes the ground was left till it was dry enough to be plowed, and was then planted. In either case sufficient moisture for the supply of the crop was retained. This system of irrigation has been supplanted for the most part in Lower Egypt by the canal system introduced by Mehemet Ali, but is still in use in Upper Egypt. The difference in the power of the two systems to maintain the fertility of the soil may be estimated from the fact that a good crop of wheat grown under the basin system of Upper Egypt yields about twenty-seven bushels per acre; while, unless specially manured, the yield runs down under canal irrigation to about eighteen bushels and a half. In the latter instance, the greater number of crops taken, and the reduced amount of Nile mud deposited, make artificial manures necessary. A combination of the two systems gives the best results. A wonderful store of natural manure, called *sabakh* has for a number of years been drawn upon by cultivators in the shape of refuse earth from the mounds of ancient villages, and from the floors and surroundings of the mud huts of the present generation. The water of the Nile holds in its volume an unusually large percentage of air; and it is probably due to this circumstance that it is so healthful and palatable even at its reddest. The crop seasons are divided into three different productive periods: the autumn, or *nili*—August till the end of November; the period of flood, in which maize, millet, sesame, and a few minor crops are grown; the summer, or *sefi*—April till July; the warm-weather period, in which tropical and semi-tropical crops—rice, sugar, and cotton—are produced; and the winter, or *shitawi*—December to March, or cold-weather period—when the European crops, grown in a temperate climate, come to maturity.

Spring Two Hundred Years ago and now.—Has change of climate within historical times, Dr. P. H. Pye-Smith asks, brought about change of diseases? "I think," he says, "we may assert that, with a few important exceptions, such as the draining which has led to the general disappearance of malaria, and the improved habitations of the poor, which have made plague unknown and typhus rare, no such changes have taken place; and in particular that there is no foundation for the opinion that in former time the English spring was milder than at present. 'The uncertain glory of an April day' was as uncertain at the close of the sixteenth as at the close of the nineteenth century. In the seventeenth century the great Earl of Verulam met his death from standing in the snow on Highgate Hill on Easter Monday, and Evelyn remarks, under date of March 27, 1681, 'An extraordinary sharp spring, not a leaf yet on the trees.' In the eighteenth century Horace Walpole writes that 'the spring has set in with its usual severity'; and the contrast between poetical description of the 'ethereal mildness of spring' and its actual inclemency has become a commonplace of satire."

Typhoid Fever and Sewage in Drinking-water.—Outbreaks of typhoid fever occurred in several of the half-dozen cities and towns situated near the junction of the Hudson and Mohawk Rivers during the winter of 1890–'91, and, while their cause can not be fixed with certainty, Prof. William P. Mason, of the Rensselaer Polytechnic Institute, holds that there is good reason to attribute them to a contaminated water-supply. In a paper read to the Franklin Institute he states that every one of these places drains into the Hudson River or its tributary, the Mohawk. There were epidemics of typhoid fever in Cohoes, West Troy, and Albany, which take their supplies of water from one or the other of these rivers; but in Waterford and Lansingburg, which take water from the Hudson above this group of towns; in Troy, which uses in part a similar supply and depends partly on the lakes back in the hills; also on Green Island, opposite Troy, which obtains sand-filtered river-water from wells, there was little or no fever besides imported cases. Ice-cutters at Van Wie's Point, four miles below Albany, who used the river-water for drinking, also had the fever break out among them. It is true that typhoid germs were not found in the water, but the facts above cited are certainly worthy of careful consideration.

Sulphuring Dried Fruit.—The dainty whiteness which commercial dried fruits have taken on within a few years is due to an unwholesome bleaching by means of the fumes of burning sulphur, which is practiced in the drying factories. Fruit-driers say that sulphuring makes the fruit dry quicker, keep better, and sell better. But these advantages do not benefit the consumer, who suffers the disadvantages, which are loss of flavor, impossibility of distinguishing unripe and poor fruit from good, and the presence of sulphide of zinc in fruit that is dried on trays having a zinc surface. This matter is thoroughly ventilated in the Transactions of the American Public Health Association by Dr. Joel W. Smith, who says further that the contamination with sulphide of zinc was the reason why American evaporated apples were excluded from Germany. He also quotes from a paper read by J. L. Mosher at a fruit-growers' convention in California the statement that "if fruit be picked before ripe, and over-sulphured to produce whiteness, it is devoid of its true rich taste and flavor, and *only requires polishing to make buttons.*"

Physiology of Over-exertion.—Pertinently to the death of a young Englishman, twenty-two years old, from syncope brought about by cold and over-exertion attendant upon a bicycle-ride of forty miles, the Lancet remarks: "It appears that this young man was a practiced bicycle-rider, and to such forty miles could hardly be considered an excessive run in a day; but, besides distance, many things have also to be considered by the judicious rider—for instance, the nature of the roads, the weather, and perhaps, above all, the pace. We know that the new machines are capable of attaining a speed never thought of a few years ago. A high speed through such cold air as prevailed on Good Friday must often be very dangerous, as likely to cause pulmonary congestion, to overcome which the heart will work at a high degree of tension, and, like any other muscle, it is likely to become paralyzed from overwork; and herein lies the danger from swift and hard riding. It would be well if our young men would remember the advice that an eminent English physiologist gave to a young man some years ago, 'Observe your strength, and keep within it.'"

NOTES.

Between four and five acres have been assigned in the forthcoming World's Columbian Exhibition to the Educational Exhibit. This is a much larger space than ever was offered before to this interest at a World's Fair. In order that the most advantage may be derived from this large privilege, the Bureau of Education has published a circular of suggestions of details as to the arrangement of the exhibit, in order that it may be made as comprehensive as possible, and as accessible in all its parts. A statement concerning the 'National Catholic Educational Exhibit, which has been determined upon, is printed on the same sheet with the department's circular.

It appears, from M. W. Brennaud's studies of the Surya Siddhanta, a book which contains the astronomy of the Hindus, that they were acquainted with the precession of the equinoxes and its effects, and with the theory of lunar and planetary movements. They had determined with fair exactness the diameter of the earth and the distance of the moon; they could calculate the orbits of the planets by the aid of the moon's daily motion in its orbit; could calculate and predict eclipses of the moon and the sun; and had a respectable knowledge of most of the fundamental problems of astronomy.

Observations made by M. Obrecht, at the observatory in Santiago, Chili, since July, 1891, show that the ground in the northwest quarter rises daily between noon and nine o'clock in the evening, and then falls back gradually till seven o'clock in the morning. Furthermore, there is a continuous rising movement of the southeast quarter, and from September to November a continuous rising of the eastern quarter. The daily variations had been observed by M. Moesta at the time the observatory was built, and by Gillis.

A few months since the Kew authorities dispatched, per the steamship Atrato, a botanical commission to the West Indies with a number of Wardian cases containing vine cuttings and Gambier plants. Unfortunately, cold weather set in, and the efforts to convey these tender plants, which had so often ended in failure, threatened once more to result in disappointment. The difficulty was that if kept on deck they would be inevitably destroyed by the low temperature; while, if taken below, the absence of light, which is so necessary to the existence of the delicate Gambier plants, was almost certain to be equally fatal. Under these circumstances it occurred to Mr. Morris to avail himself of the electric light, of which there was an abundance on board the Atrato. The experiment proved in every way successful.

The extent of the influence a lake may exercise upon climate is illustrated by the statement of M. Forel that the quantity of heat accumulated in Lake Leman during the summer is equivalent to that which would be given out by the burning of fifty-one million tons of coal. A railroad train carrying this coal would be eighteen thousand kilometres long, or nearly the length of the earth's meridian from pole to pole.

A story is told of a brown retriever dog in London which was sent to carry a letter in its mouth to drop in the post-box at Piccadilly. It got to the box just as the postman, having emptied it, was starting away. The dog seeing him, ran after him, caught up with him, put the letter in his hand, and then went off with the satisfied air of a dog that had done its duty.

Of the "rare metals," didymium is quoted at $4,500 a pound; barium, at $3,700; beryllium or glucinum, at $3,375; yttrium, at $2,250; rhodium and niobium or columbium, at $2,000 each; vanadium, at $1,875; iridium, at $700; osmium, at $625; palladium, at $500; and platinum, at $350. The price of the last metal, however, fluctuates between those of silver and gold.

M. Berthelot has traced the derivation of the word bronze to the city of Brundusium, now Brindisi, where was the seat of certain manufactures in which the alloy was employed. A Latin manuscript of the age of Charlemagne, found in the library of the chapter of the Canons of Luynes, gives a receipt for the "composition of Brindisi"—copper, two parts; lead, one part; tin, one part.

Among the interesting objects exhibited at a recent *soirée* of the Royal Society was a proof-sheet of the Archæological Survey of Egypt, by Mr. Percy E. Newberry, showing all the successive stages of a wrestling-match between a black and a white man, with more than a hundred different positions recorded. The white man seems in many of the pictures to be getting the worst of it.

A foolish report that the Department of Agriculture contemplated introducing the mongoose to contend with the rodents of the Western plains, so troublesome to farmers—with the ultimate result, of course, of taking their place as a nuisance—has been denied by the department.

A new preparation of the potato has been introduced by M. Moulin, the inventor of the potato bread, and is intended chiefly for feeding to cattle. The cleaned potatoes are scraped or crushed; the pulp is pressed for the extraction of free water; is finely divided; and is dried with a moderate heat sufficient to give it a pleasant taste without converting the starch into dextrin. The product is called torrefied pulp. It may also be used for human food by making a *purée* of it, or by making bread of a mixture of it with flour or meal.

At the last meeting of the American Philosophical Society in Philadelphia resolutions were adopted for the celebration in a worthy and becoming manner of the sesquicentennial anniversary of the society; and a committee of five members was appointed to make all necessary arrangements for the same. The society celebrated the centennial anniversary of its foundation in 1843, with a series of addresses, meetings, etc., continuing from the 25th to the 30th of May.

The last giraffe in the London Zoölogical Gardens has recently died, and the institution is, for the first time since 1836, without a living specimen of this animal. It has had in all thirty specimens, of which seventeen were born on the place. The giraffe market is very poorly supplied, and there is but one specimen now for sale in Europe. The giraffe is practically extinct in South Africa, and can not be found within a thousand miles of Cape Town. There are still giraffes in East Africa, but there are no means of catching them.

The aborigines of the Andaman Islands, a curious and even unique people, are said to be fast disappearing. All of them on two of the islands are dead, and only a few are left on a third. Only a small number of children are born, and they die in infancy.

The Yahgan, one of the three tribes inhabiting Tierra del Fuego, according to Dr. Hyades, live chiefly on fish and mollusks. They also eat any kind of bird they can catch, and are fond of the flesh of the whale, the seal, and the otter. When pressed with hunger they will eat the fox, but never dogs or rats. Fishing is left to the women, while the men hunt. The people have splendid powers of digestion, and assimilate their food so rapidly that they sometimes become fat in the course of a single day. Their huts are made of branches or of the trunks of trees, the interstices being imperfectly filled up with moss or bark, with fragments of canoes, or with seal-skins. In the center is a fire, around which the inmates sleep at night, and at other times, when they have nothing else to do, sit talking and laughing. The Yahgan lose early the attributes of youth, but often retain their vigor to a great age. They are very courageous, and enjoy games that test their physical strength.

With the exception of certain Eskimo throw-sticks, Mr. Otis T. Mason remarks in Science that all the weapons of the Northwestern American Indians examined by him are ambidextrous; and he questions whether outside of the Eskimo area any American aborigines had apparatus that would not fit either hand.

Among the particular schemes connected with the celebration of the Columbian quadricentennial is that for a great food exhibition to be held in New York in October, 1892, under the auspices of the Food Manufacturers' Association. It will include displays of manufactured foods and of products direct from the dairy, orchard, and sea, and a special department of dairy products, with daily afternoon and evening concerts.

OBITUARY NOTES.

The death is reported of August Wilhelm Hoffmann, the eminent German chemist, Professor in the University of Berlin, and author of many discoveries that have contributed to the advancement of the science. A sketch and portrait of him were published in The Popular Science Monthly for April, 1884.

Henri Duveyrier, a famous explorer and formerly President of the French Geographical Society, died about the beginning of May. He was born in 1840, and began, when twenty years old, a series of journeys in Algeria which made him famous. They included a reconnaissance to El Golea, where no European had ever set foot; southern Constantine and the Tunisian Soudan; the country of the Tuaregs; and the Chots of southern Tunis.

WILLIAM BARTRAM.

THE

POPULAR SCIENCE MONTHLY.

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NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XVII.—GEOGRAPHY.

By ANDREW DICKSON WHITE, LL. D., L. H. D.,
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PART II.

3. The Inhabitants of the Earth.—Even while the question of the sphericity of the earth was undecided, another question had been suggested which the Church held to be of far greater importance. The doctrine of the earth's sphericity naturally led to thought upon the tenants of the earth's surface, and another ancient germ idea was warmed into life—the idea of the antipodes—of human beings on the earth's opposite sides.

At this the theological warriors of the Church waxed valiant. Those great and good churchmen determined to fight. To all of them this idea seemed dangerous, to most of them it seemed damnable. St. Basil and St. Ambrose were tolerant enough to allow that a man might be saved who thought the earth inhabited on its opposite sides, but the great majority of the fathers of the Church doubted the possibility of salvation to such misbelievers.

Lactantius asks: "Is there any one so senseless as to believe that there are men whose footsteps are higher than their heads? . . . that the crops and trees grow downward? . . . that the rains and snow and hail fall upward toward the earth? . . . I am at a loss what to say of those who, when they have once erred, steadily persevere in their folly, and defend one vain thing by another."

But a still greater man followed on the same side. St. Augustine seemed inclined to yield a little in regard to the sphericity of the earth, but he fought the idea that men exist on the other side of it, saying that "Scripture speaks of no such descendants of Adam." He insists that men could not be allowed by the Almighty to live there, since if they did they could not see Christ at his second coming descending through the air. But his most cogent appeal, one which we find echoed from theologian to theologian during a thousand years afterward, is to the nineteenth Psalm, and to its confirmation in the Epistle to the Romans; to the words, "Their line is gone out through all the earth, and their words to the end of the world." He dwells with great force on the fact that St. Paul based one of his most powerful arguments upon this declaration regarding the preachers of the gospel, declaring even more explicitly that "verily their sound went into all the earth, their words unto the ends of the world." Henceforth we find it constantly declared that, as those preachers did not go to the antipodes, no antipodes can exist; and therefore that the supporters of this geographical doctrine "give the lie direct to King David and to St. Paul, and therefore to the Holy Ghost." Augustine taught the whole world for over a thousand years that as there was no preaching of the gospel on the opposite side of the earth, there could be no human beings there.

The great authority of Augustine and the cogency of his scriptural argument held the Church, as a rule, firmly against the doctrine of the antipodes; yet that the doctrine continued to have life is shown by the fact that in the sixth century Procopius of Gaza attacks it with a tremendous argument. He declares that if there be men on the other side of the earth, Christ must have come to save them; and, therefore, that there must have been there, as necessary preliminaries to his coming, a duplicate Eden, Adam, Serpent, and Deluge.

Cosmas Indicopleustes also attacked the doctrine with especial bitterness, citing a passage from St. Luke to prove that antipodes are theologically impossible.

At the end of the sixth century comes a man from whom much might be expected—St. Isidore of Seville. He had pondered over ancient thought in science, and, as we have seen, had dared proclaim his belief in the sphericity of the earth; but with that he stopped. As to the antipodes, the authority of the Psalmist, St. Paul, and St. Augustine silences him; he shuns the whole question as unlawful, subjects reason to faith, and declares that men can not and ought not to exist on opposite sides of the earth.*

* For the opinions of Basil, Ambrose, and others, see Lecky, History of Rationalism in Europe, New York, 1872, vol. i, p. 279, note. Also Letronne, in Revue des Deux Mondes, March, 1834. For Lactantius, see citations already given. For St. Augustine's opinion, see the Civ. Dei, xvi, 9, where this great father of the Church shows that the existence of the

Under such pressure this scientific truth seems to have disappeared for nearly two hundred years, but by the eighth century the sphericity of the earth had come to be generally accepted among the leaders of thought, and now the doctrine of the antipodes was again asserted by a bishop, Virgil of Salzburg.

There then stood in Germany, in those first years of the eighth century, one of the greatest and noblest of men—St. Boniface. His learning was of the best then known. In labors he was a worthy successor of the apostles; his genius for Christian work made him unwillingly primate of Germany; his devotion to duty led him willingly to martyrdom. There sat too, at that time, on the papal throne a great Christian statesman—Pope Zachary. Boniface immediately declared against the revival of such a heresy as the doctrine of the antipodes; he stigmatized it as an assertion that there are men beyond the reach of the appointed means of salvation; he attacked Virgil, and called on Pope Zachary for aid.

The Pope, as the infallible teacher of Christendom, makes a strong response. He cites passages from the book of Job and the Wisdom of Solomon against the doctrine of the antipodes; he declares it "perverse, iniquitous, and against Virgil's own soul," and indicates a purpose of driving him from his bishopric. Whether this purpose was carried out or not, the old theological view, by virtue of the Pope's divinely ordered and protected "inerrancy," was re-established, and the doctrine that the earth has inhabitants on but one of its sides became more than ever orthodox, and, in the mind of the Church, necessary to salvation.*

This decision seems to have been regarded as final, and two centuries later the great encyclopedist of the middle ages, Vin-

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antipodes "nulla ratione credendum est." Also citations in Buckle's Posthumous Works, vol. ii, p. 645. For Procopius of Gaza see Kretschmer, p. 55. See also, on the general subject, Peschel, Geschichte der Erdkunde, pp. 96, 97. For Isidore, see citations already given. To understand the embarrassment caused by these utterances of the fathers to scientific men of a later period, see Letter of Agricola to Joachimus Vadianus in 1514. Agricola asks Vadianus to give his views regarding the antipodes, saying that he himself does not know what to do, between the fathers on the one side and the learned men of modern times on the other. On the other hand, for the embarrassment caused to the Church by this mistaken zeal of the fathers, see Kepler's references and Fromund's replies; also De Morgan, Paradoxes, p. 58. Kepler appears to have taken great delight in throwing the views of Lactantius into the teeth of his adversaries.

* For Virgil of Salzburg, see Neander's History of the Christian Church, Torrey's translation, vol. iii, p. 63. Also Herzog, Real. Encyclopaedie, etc., recent edition by Prof. Hauck, *in verb. Virgilius.* Also Kretschmer. See Whewell, i, p. 197; but for best choice of authorities and for most careful winnowing out of conclusions, see De Morgan, pp. 24–26. For very full notes as to pagan and Christian advocates of the doctrine of the sphericity of the earth and of the antipodes, and for extract from Zachary's letter, see Migne, Patrologia, vol. vi, p. 426, and vol. xli, p. 487. For St. Boniface's part, see Bonifacii Epistolæ, ed. Giles, i, 173.

cent de Beauvais, though he accepts the sphericity of the earth, treats the doctrine of the antipodes as utterly disproved. Yet the doctrine still lived. Just as it had been previously revived by William of Conches and then laid to rest, so now it is somewhat timidly brought out in the thirteenth century by no less a personage than Albert the Great, the most noted man of science in that time. But his utterances are perhaps purposely obscure. Again it disappears beneath the theological wave, and a hundred years later Nicolas d'Oresme, Geographer of the King of France, a light of science, is forced to yield to the clear teaching of the Scripture as cited by St. Augustine.

Nor was this the worst. In Italy, at the beginning of the fourteenth century, the Church thought it necessary to deal with questions of this sort by rack and fagot. In 1316 Peter of Abano, famous as a physician, having promulgated this with other obnoxious doctrines in science, only escaped the Inquisition by death; and in 1327 Cecco d'Ascoli, noted as an astronomer, was for this and similar crimes driven from his professorship at Bologna and burned alive at Florence. Nor was this all his punishment: that great painter, Orcagna, whose terrible works still exist on the walls of the Campo Santo at Pisa, immortalized Cecco by representing him in the flames of hell.*

Years rolled on, and there comes in the fifteenth century one from whom the world had a right to expect much. Pierre d'Ailly, by force of thought and study had risen to be Provost of the College of St. Dié in Lorraine; his ability had made that little country village a center of scientific thought for all Europe, and finally made him Archbishop of Cambray and a cardinal. In 1483 was printed what Cardinal d'Ailly had written long before as a summing up of his best thought and research—the collection of essays known as the Ymago Mundi. It gives us one of the most striking examples in history of a great man in theological fetters. As he approaches this question he states it with such clearness that we expect to hear him assert the truth; but there stands the argument of St. Augustine; there, too, stands the biblical texts on

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* For Vincent de Beauvais and the antipodes, see his Speculum Naturales, Book VII, with citations from St. Augustine, De Civitate Dei, cap. xvi. For Albert the Great's doctrine regarding the antipodes, compare Kretschmer as above with Eicken, Geschichte, etc., p. 621. Kretschmer finds that Albert supports the doctrine, and Eicken finds that he denies it—a fair proof that Albert was not inclined to state his views with dangerous clearness. For D'Oresme, see Santarem, Histoire de la Cosmographie, vol. i, p. 142. For Peter of Abano, or Apono, as he is often called, see Tiraboschi; also Ginguené, vol. ii, p. 293; also Naudé, Histoire des Grands Hommes de Magie. For Cecco d'Ascoli, see Montucla, Histoire des Mathematiques, i, 528; also Daunou, Études Historiques, vol. vi, p. 320; also Kretschmer, p. 59. Concerning Orcagna's representation of Cecco in flames of hell, see Renan, Averroes et l'Averroisme, Paris, 1867, p. 328.

which it is founded; the text from the Psalms and the explicit declaration of St. Paul to the Romans, "Their sound went into all the earth, and their words unto the ends of the world." D'Ailly attempts to reason, but he is overawed, and gives to the world virtually nothing.

Still, the doctrine of the antipodes lived and moved: so much so, that the eminent Spanish theologian Tostatus, even as late as the age of Columbus, feels called upon to protest against it as "unsafe." He has shaped the old missile of St. Augustine into the following syllogism: "The apostles were commanded to go into all the world and to preach the gospel to every creature; they did not go to any such part of the world as the antipodes; they did not preach to any creatures there; *ergo,* no antipodes exist."

The warfare of Columbus the world knows well—how the Bishop of Ceuta worsted him in Portugal; how sundry wise men of Spain confronted him with the usual quotations from the Psalms, from St. Paul, and from St. Augustine; how, even after he was triumphant, and after his voyage had greatly strengthened the theory of the earth's sphericity, with which the theory of antipodes was so closely connected, the Church by its highest authority solemnly stumbled and persisted in going astray. In 1493 Pope Alexander VI, having been appealed to as an umpire between the claims of Spain and Portugal to the newly discovered parts of the earth, issued a bull laying down upon the earth's surface a line of demarkation between the two powers. This line was drawn from north to south a hundred leagues west of the Azores; and the Pope in the plenitude of his knowledge declared that all lands discovered east of this line should belong to the Portuguese and all west of it should belong to the Spaniards. This was hailed as an exercise of divinely illuminated power by the Church; but difficulties arose, and in 1506 another attempt was made by Pope Julius II to draw the line three hundred and seventy leagues west of the Cape Verd Islands. This, again, was supposed to bring divine wisdom to settle the question, but shortly overwhelming difficulties arose; for the Portuguese claimed Brazil, and, of course, had no difficulty in showing that they could reach it by sailing to the east of the line, provided they sailed long enough. The lines laid down by Popes Alexander and Julius may still be found upon the maps of the period, but their bulls have quietly passed into the catalogue of ludicrous errors.

Yet the theological barriers to this geographical truth yielded but slowly. Plain as it had become to scholars, they hesitated to declare it to the world at large. Eleven hundred years had passed since St. Augustine had proved its antagonism to Scripture, when Gregory Reysch gave forth his famous encyclopædia, the Margarita Philosophica. Edition after edition was issued, and everywhere appeared in it the orthodox statements; but they were evidently strained to the breaking point; for, while in treating of the antipodes Reysch refers respectfully to St. Augustine as objecting to the scientific doctrine, he is careful not to cite Scripture against it, and is not less careful to cite geographical reasoning in favor of it.

But in 1519 science gains a crushing victory. Magellan makes his famous voyage. He proves the earth to be round, for his expedition circumnavigates it; he proves the doctrine of the antipodes, for he sees the peoples of the antipodes. Yet even this does not end the war. Many conscientious men oppose the doctrine for two hundred years longer. Then the French astronomers make their measurements of degrees in equatorial and polar regions, and add to their proofs that of the lengthened pendulum. When this was done, when the deductions of science were seen to be established by the simple test of measurement, beautifully and perfectly, and when a long line of trustworthy explorers had sent home accounts of the antipodes, then, and then only, this war of twelve centuries ended.

Such was the main result of this long war; but there were other results not so fortunate. The efforts of Eusebius, Basil, and Lactantius to deaden scientific thought; the efforts of Augustine to combat it; the efforts of Cosmas to crush it by dogmatism; the efforts of Boniface and Zachary to crush it by force, conscientious as they all were, had resulted simply in impressing upon many noble minds the conviction that science and religion are enemies.

On the other hand, what was gained by the warriors of science for religion? Certainly a far more worthy conception of the world and a far more ennobling conception of that Power which pervades and directs it. Which is more consistent with a great religion, the cosmography of Cosmas or that of Isaac Newton? Which presents a nobler field for religious thought, the diatribes of Lactantius or the calm statements of Humboldt? *

* For D'Ailly's acceptance of St. Augustine's argument, see the Ymago Mundi, Paris, 1490, cap. vii. For Tostatus, see Zöckler, vol. i, pp. 467, 468. He based his opposition on Romans, x, 18. For Columbus, see Winsor, Fiske, and Adams; also Humboldt, Histoire de la Géographie du Nouveau Continent. For the bull of Alexander VI, see Daunou, Ètudes Historiques, vol. ii, p. 417; also Peschel, Zeitalter der Entdeckungen, Book II, chap. iv. The text of the bull is given with the English translation in Arber's reprint of The First Three English Books on America, etc., etc., Birmingham, 1885, pp. 201–204; also especially Peschel, Die Theilung der Erde unter Papst Alexander VI. und Julius II., Leipsic, 1871, pp. 14 *et seq.* For remarks on the power under which the line was drawn by Alexander VI, see Mamiani, Del Papato ne'i Tre Ultimi Secoli, p. 170. For maps showing lines of division, see Kohl, Die beiden altesten General-Karten von Amerika, Weimar, 1860, where maps of 1527 and 1529 are reproduced; also Mercator, Atlas, tenth edition, Amsterdam, 1628, pp. 70, 71. For latest discussion on The Demarkation Line of Alex-

4. The Size of the Earth.—But at an early period another subject in geography had stirred the minds of thinking men—the earth's size. Various ancient investigators had by different methods reached measurements more or less near the truth; these methods were continued into the middle ages, supplemented by new thought, and among the more striking results were those obtained by Roger Bacon and Gerbert, afterward Pope Sylvester II. They handed down to after-time the torch of knowledge, but, as their reward among their contemporaries, they fell under the charge of sorcery.

Far more consonant with the theological spirit of the middle ages was a solution of the problem from Scripture, and this solution deserves to be given as an example of a very curious theological error, chancing to result in great good. The second book of Esdras, which among Protestants is placed in the Apocrypha, was held by many of the foremost men of the ancient Church as fully inspired: though Jerome looked with suspicion on this book, it was regarded as prophetic by Clement of Alexandria, Tertullian, and Ambrose, and the Church acquiesced in that view. In the Eastern Church it held an especially high place, and in the Western Church, before the Reformation, was generally considered by the most eminent authorities to be part of the sacred canon. In the sixth chapter of this book there is a summary of the works of creation, and in this occur the following verses:

"Upon the third day thou didst command that the waters should be gathered in the seventh part of the earth; six parts hast thou dried up and kept them to the intent that of these some, being planted of God and tilled, might serve thee."

"Upon the fifth day thou saidst unto the seventh part where the waters were gathered, that it should bring forth living creatures, fowls and fishes, and so it came to pass."

These statements were reiterated in other verses, and were naturally considered as of controlling authority.

Among the scholars who pondered on this as on all other things likely to increase knowledge was Cardinal Pierre d'Ailly. As we have seen, this great man, while he denied the existence of

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ander VI, see E. G. Bourne in Yale Review, May, 1892. For the Margarita Philosophica, see the editions of 1503, 1509, 1517, lib. vii, cap. 48. For the effect of Magellan's voyages, and the reluctance to yield to proof, see Henri Martin, Histoire de France, vol. xiv, p. 395; St. Martin's Histoire de la Géographie, p. 369; Peschel, Geschichte des Zeitalters der Entdeckungen, concluding chapters; and for an admirable summary, Draper, Hist. Int. Devel. of Europe, pp. 451–453; also an interesting passage in Sir Thomas Browne's Vulgar and Common Errors, Book I, chap. vi. For general statement as to supplementary proof by measurement of degrees and by pendulum, see Somerville, Phys. Geog., chap. i, par. 6, note; also Humboldt, Cosmos, vol. ii, p. 736, and v, pp. 16, 32; also Montucla, iv, 138.

the antipodes as St. Augustine had done, believed firmly in the sphericity of the earth, and, interpreting these statements of the book of Esdras in connection with this belief, he held that, as only one seventh of the earth's surface was covered by water, the ocean between the west coast of Europe and the east coast of Asia could not be very wide. Knowing, as he thought, the extent of the land upon the globe, he felt that in view of this divinely authorized statement the globe must be much smaller, and the land of "Zipango," reached by Marco Polo, on the extreme east coast of Asia, much nearer than had been generally believed.

On this point he laid stress in his great work, the Ymago Mundi, and an edition of it having been published in the days when Columbus was thinking most closely upon the problem of a westward voyage, it naturally exercised much influence upon his reasonings. Among the treasures of the library at Seville, there is nothing more interesting than a copy of this work annotated by Columbus himself; from this very copy it was that Columbus obtained confirmation of his belief that the passage across the ocean to Marco Polo's land of Zipango in Asia was short. But for this error, based upon a text supposed to be inspired, it is unlikely that Columbus would have had the courage to undertake his voyage. It is a curious fact that this single theological error thus promoted a series of voyages which completely destroyed not only this but every other conception of geography based upon the sacred writings.*

5. The Character of the Earth's Surface.—It would be hardly just to dismiss the struggle for geographical truth without referring to one passage more in the history of the Protestant Church, for it shows clearly the difficulties in the way of the simplest statement of geographical truth which conflicted with the words of the sacred books.

In the year 1553 Michael Servetus was on trial for his life at Geneva on the charge of Arianism. Servetus had rendered many services to scientific truth, and one of these was an edition of Ptolemy's Geography, in which Judea was spoken of, not as "a land flowing with milk and honey," but, in strict accordance with the truth, as, in the main, meager, barren, and inhospitable. In his trial this simple statement of geographical truth was used

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* For this error, so fruitful in discovery, see D'Ailly, Ymago Mundi (my own copy is of 1490); the passage referred to is folio 12 verso. For the passage from Esdras, see chap. vi, verses 42, 47, 50, and 52; see also Zöckler, Geschichte der Beziehungen zwischen Theologie und Naturwissenschaft, vol. i, p. 461. For one of the best recent statements, see Ruge, Gesch. des Zeitalters der Entdeckungen, Berlin, 1882, pp. 221 *et seq.* For the letter of Columbus acknowledging his indebtedness to this mistake in Esdras, see Navarrete, Viajes y Descubrimientos, Madrid, 1825, tome i, pp. 242–264; also Humboldt, Hist. de la Géographie du Nouveau Continent, vol. i, pp. 68, 69.

against him by his arch-enemy John Calvin with fearful power. In vain did Servetus state the fact that he had simply drawn the words from a previous edition of Ptolemy; in vain did he declare that this statement was a simple geographical truth of which there were ample proofs; it was answered that such language "necessarily inculpated Moses, and so grievously outraged the Holy Ghost." *

In summing up the action of the Church upon Geography, we must say, then, that the dogmas developed in the strict adherence to Scripture and the conceptions held in the Church during many centuries "always, everywhere, and by all," were, on the whole, steadily hostile to truth; but it is only just to make a distinction here between the religious and the theological spirit. To the religious spirit are largely due several of the noblest among the great voyages of discovery. A deep longing to extend the realms of Christianity influenced the minds of Prince John, of Portugal, in his great series of efforts along the African coast; of Vasco da Gama, in his circumnavigation of the Cape of Good Hope; of Magellan, in his voyage around the world, and doubtless found a place among the more worldly motives of Columbus.

Thus, in this field also, from the supremacy accorded to theology, we find resulting that tendency to dogmatism which has shown itself in all ages the deadly foe not only of scientific inquiry but of the higher religious spirit itself, while from the love of truth for truth's sake, which has been the inspiration of all fruitful work in science, nothing but advantage has ever resulted to true religion.

The Japanese dragon is supposed by Mr. Charles De Kay to be possibly a remnant of the original native religion which was superseded by Buddhism in China and Japan. Compared with the monster as depicted in stone and colors by artists of our middle ages, it is a graceful creature. Dragons a foot or two long, made of an incredible number of pieces held together, are among the marvels of Japanese workers in iron and bronze, and great prices are paid when the foundry-man or ironsmith is a famous artist. The figures sometimes have a character of their own which justifies one in placing them among serious works of art. When taken in the hand their flexibility and coldness make them seem alive; while their singular motions and threatening look express capitally the fierceness and wayward nature attributed to a symbol of the least stable of elements. To us and to skeptical natives the image is a curious, ingenious plaything, but to the Japanese of the old religions or to the Buddhist it means a good deal more: it is a talisman to exorcise the dangers that lie on land and sea.

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* For Servetus's geographical offense, see Willis, Servetus and Calvin, London, 1877, p. 325. The passage condemned is in the Ptolemy of 1535, folio 41. It was discreetly retrenched in a reprint of the same edition. As to the mixture in the motives of Columbus, it may be well to compare with the earlier biographies the recent ones by Dr. Winsor and President Adams.

THE DELAWARE INDIAN AS AN ARTIST.

By Dr. CHARLES C. ABBOTT.

WHEN a considerable collection of the stone and bone handiwork of the Delaware Indians has been brought together, and with this material before us we picture to ourselves the people in possession of the country when first visited by the Dutch and Swedes, and afterward by the English, the thought arises that considerable importance must be given to a chance remark of Peter Kalm, who spent the winter of 1748–'49 in New Jersey—to wit: "At the first arrival of the *Swedes* in this country, and long after that time, it was filled with *Indians*. But as the *Europeans* proceeded to cultivate the land, the *Indians* sold their land, and went further into the country. But in reality few of the *Indians* really left the country in this manner; most of them ended their days

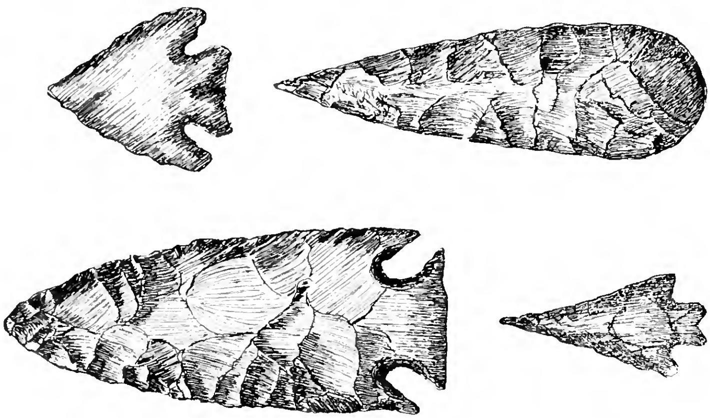

Fig. 1.—Common Forms of Arrow-points from New Jersey.

before, either by wars among themselves, or by the small-pox, a disease which the *Indians* were unacquainted with before their commerce with the *Europeans*, and which since that time has killed incredible numbers of them." Again, our author states: "The *Indians* formerly, and about the time of the first settling of the Swedes, were more industrious and laborious in every branch of business than they are now." In other words, they were not known at their best, even by those who had earliest opportunities of observing them, and what they habitually used and constantly produced, perhaps, but a century or two before the advent of the European, was far superior to their cleverest handiwork in the seventeenth century. The European had to do with a diseased, discouraged, and disappearing people. It is safe to assert that history, as pertaining to the Delaware Valley, would have been widely different had the European been forced to deal, not with the Lenni Lenâpé as they then were, but as they had been. True, there were statesmen still among them; intellects equal to any with which they had to cope; but the spirit that once seems to have animated the whole nation was broken. The Indians of the seventeenth century were living on the memory of departed glory. Not one of the many writers that have given us an account of what he saw in use among these people, when the Indian still pos-

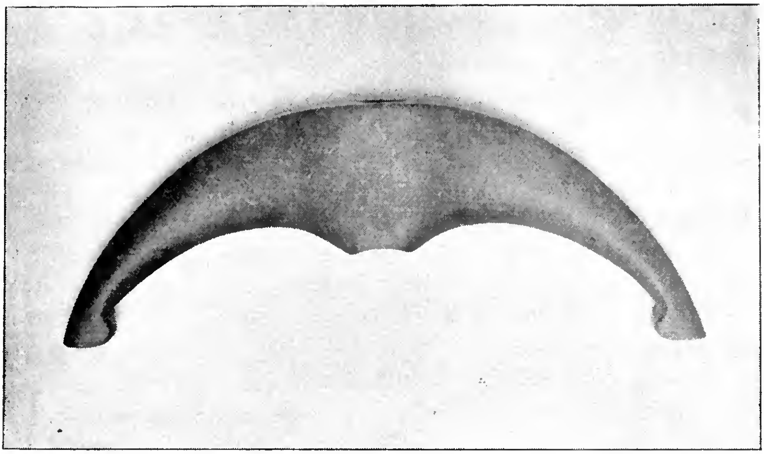

FIG. 2.—STONE CEREMONIAL OBJECT.

sessed the land, refers to many a curious form of stone or bone object, that now for want of knowledge on the subject we call an "ornament," or take refuge behind so convenient a term as "implement." That such objects are full of meaning, could we but decipher it, there is not a doubt.

It is true that, until the products of their handicraft were replaced by similar objects of European manufacture, the Indians were adepts in flint-chipping; made from pebbles shapely axes; carved wooden mortars and even large canoes, and fashioned well-designed pipes both of stone and clay. But what of the far more artistic bird-shaped stones, the so-called ceremonial objects, elaborate gorgets, and even idols? These are found to-day in sufficient numbers to indicate that they were once a prominent if not common feature of every village; but how could they have been overlooked by the Europeans who described their axes and arrow-points, if still in use? They had, it is logical to assume, disappeared from the scene; or, retained, were "relics" in the eyes of their possessors. It is not unwarranted to say, as concerning the Delaware Valley, that when Cornelius Mey discovered the Delaware River, there were Indian "relics" then to be had; and had it dawned upon the mind of some bright Lenâpé then, he could have gathered, as the antiquities of his own country, objects bearing the same relationship to him that his own axe and arrows do to

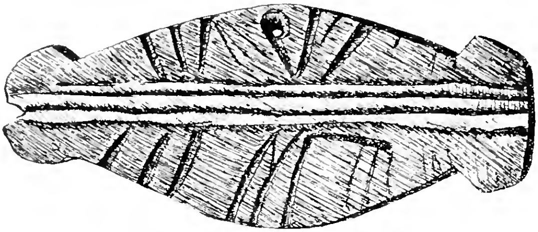

Fig. 3.—Etched Steatite Gorget from Pennsylvania.

us. The Indian of 1600 was, at least in some respects, the degenerate descendant of the aborigine of A. D. 1000, or later.

If, then, it may be asked, the Delaware Indians produced, in prehistoric times, objects exhibiting a more advanced culture than did their descendants in historic times or just preceding them, where are such objects now? Has tangible evidence of this assertion been produced? In the Delaware Valley I think it has. There have occasionally been found in single graves, or lying in or on the ground, unassociated articles, clearly of Indian origin, and

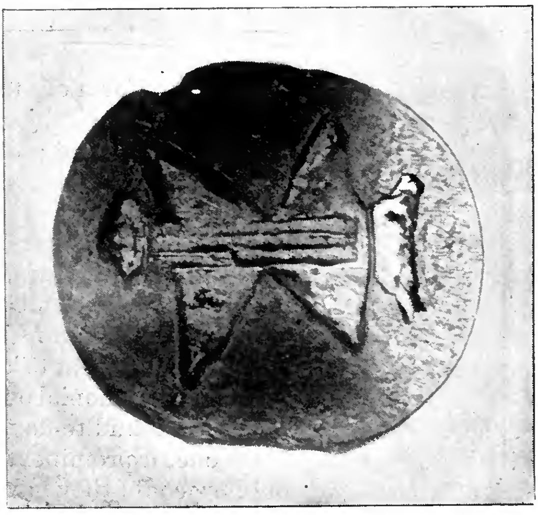

Fig. 4.—Stone Gorget. Delaware Indian.

yet not similar to the ordinary "finds" characteristic of Indian village sites. For instance, there have been burial-places examined in this river valley, from which scores of skeletons have been taken, and with them only the most commonplace objects were found, and many an interment was without any object of stone, bone, or clay. On the other hand, in some lonely spot, some little knoll in a forest, or prominent ridge of earth extending out upon a level meadow tract, a single grave has been found, where objects of a high grade of workmanship and suggesting a distinct advance over the historic Indian occurred. The whole character of the interment was different from that of the average or ordinary Indian grave. There is obvious danger, it is true, from drawing too broad a conclusion from a few such graves. Doubtless the Indian "king" would be interred with greater pomp and with finer possessions than the Indian warrior; but in such instances as I have mentioned, the objects found have been different in character as well as of superior workmanship. In such a matter the best that can be done, with our present stock of knowledge, is to express, tentatively of course, that this or that condition was probably true; and surveying the whole valley, after twenty years of tramp-

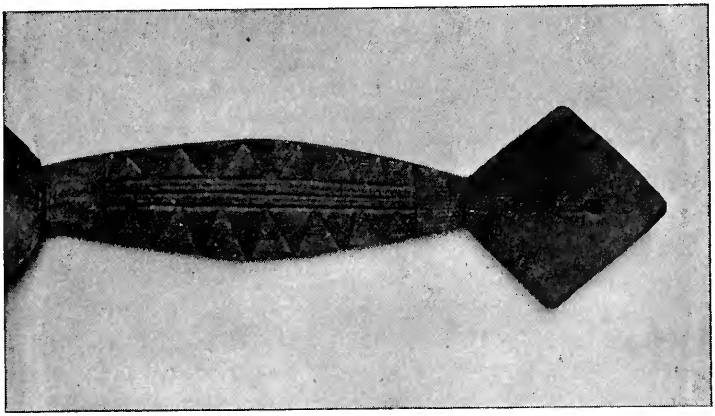

Fig. 5.—Handle of Wooden Spoon. Modern Chippewa.

ing about it from the mountains to the sea, I have been forcibly impressed with the evidence, first, of man's antiquity in this region, of his gradual progress from a very primitive to a more cultured condition, and of retrogression at the dawn of the historic period.

Much might be said of the skill of the Delaware Indian in all of the many phases of his industry, but I propose only to speak of him as an artist. A love of bright colors was always, and is, a prominent characteristic, and probably the first attempt at personal adornment was the attachment to the person of feathers and small stones of bright hues. Mica and quartz crystals are common in graves. The glitter and glistening of these would be sure to attract. But what of the next step, that of shaping from formless masses objects that strike the fancy of the wearer? To shape a pebble that it might better meet the needs of a club-head or hatchet called for little skill, and the labor of making an axe has recently been shown to be but slight; but the idea of symmetry was developed and cultivated until a weapon was finally produced that can not be improved upon. The same is true of chipping from flint points for arrow-shafts. A mere splinter of stone, if sharp and narrow, would be as effective as any shape that could be devised; but such chance splinters do not appear to have been used, except directly after the invention of the bow and arrow; and, so far as is now discoverable, a series of artistically designed patterns have been in use for hundreds of years. Fig. 1 represents four arrow-points such as are common everywhere in the valley of the Delaware. The flint-worker who made these had something more than mere utilitarianism in his constitution. A love of the beautiful, of symmetry, of neatness, call it what you will, was well developed. Not one of these would kill a bird or beast one whit quicker than the simple triangular arrow-point; and yet these more elaborate forms are more abundant than those of simpler outline.

I am tempted to suggest that possibly the late (comparatively speaking) use of jasper, here in the valley of the Delaware, may have been generally adopted largely because of the bright colors of that material. Of various tints, and often so veined that even a small object might be partycolored, it is little wonder that the use of jasper became so wide-spread, and argillite in a measure neglected; and yet the latter served every purpose, and from the days of Palæolithic man to the coming of the Dutch and Swedes was never discarded. But argillite is dull gray when old, and never bright or glossy, however newly chipped; while the jasper was red or yellow, green, blue, or variegated, and never lost its brilliancy. Little wonder it was in such demand, and the labor of mining undergone. Its color, doubtless, had much to do with its adoption.

Symmetry, as developed in fashioning the axe and celt, which were pecked and not chipped, as were arrow-points, soon led to the same methods being applied to stone for the production of more elaborately designed objects, and the so-called "ceremonial" forms were made. Fig. 2 represents a nearly faultless example of these common "relics," the purpose of which can only be conjectured. The Indian who shaped this specimen was no "'prentice-hand." He may not have been an artist in the common acceptation of that term; but he needed, to say the least, very little instruction to make him one. Objects of this character are of such remarkable abundance, although seldom of such beauty of finish as is this, that the relic-hunter in his tramps over the fields is continually wondering what they were intended for. I have found fragments of twenty in one day, and this more than once; but they are not, I think, found in the ordinary clustered graves of the Indians. In single graves, with other odd forms, they have occasionally been found. Fig. 2 is perforated at the middle, and so was intended to be attached to a handle. As a baton-head it would be an attractive object, and, if the staff was further decorated with bright feathers and other trinkets, the whole would be very effective in dance or parade. But what be-

Fig. 6.—Stone Ornament representing Human Face. Susquehanna River, Pa.

came of them all in the days of the first European settlers? Could it be possible they were still in common use, and yet not one writer make mention of them?

But, besides symmetrically shaping stone into ornamental forms, the Delaware Indian was given to ornamenting the smooth surfaces of objects by series of lines and dots, in such regular manner that the eye is pleased. A simple example of this phase of ornamentation is shown in Fig. 3. This is a common gorget, the outline of which is purely fanciful. But it is rendered more attractive by parallel and oblique lines, arranged in a manner that suggests not so much hap-hazard fancy as the highly conventionalized representation of some animal form. This is confirmed, I think, by referring to Fig. 4, which represents another specimen of gorget of most interesting character. The difference between the two is very decided, and yet the relationship is not lost. What, indeed, the figure depicted on this circular gorget is intended for is problematical. That it is animal-like no one will dispute. And with the two gorgets described, both of which are very old and made of stone, compare the illustration here given (Fig. 5) of the handle of a wooden spoon, of very recent date. Here we see the same ornamentation or representation of the same idea. It is scarcely probable that this should have been accidental, and is, further, an exemplification of the expression of an idea by symmetrically arranged lines, and not an effort merely to relieve the monotony of a plain surface.

Fig. 7.—Miniature Wooden Mask. Delaware Indian.

We are now brought to consider realistic representations of familiar objects. The human face is one of these; and whether the Indian first made a few lines and dots to express it, or correctly depicted it, is difficult to determine. It can be made to appear very forcibly, upon a smooth surface, by two dots and two lines, thus: • | •; but did the Indian ever adopt such means? I have never seen it, but Fig. 6 is certainly an approach to

Fig. 8.—Miniature Wooden Mask. Delaware Indian.

such simplicity of illustration. This interesting specimen was recently found on an island in the Susquehanna Valley, and certainly is a most striking example of effective portraiture by means of a few lines and dots.

Having shown how a stone surface was altered to produce either a purely ornamental or a pictorial effect, let me offer now some striking examples of how the artistic efforts of the Indian showed themselves in carving in other substances than stone. This was, of course, a much more difficult matter. Stone is, if not too hard, easily shaped by hammering, its surface yielding to constant hammering with another stone. To shape a bit of wood is another matter, but that the Indian was abundantly capable of this, I offer Fig. 7 as evidence. Here we have an instance of the artist's skill in more than one direction. As we look at the illustration, we see the human face grotesquely represented, and at the same time the portrait is equally good, or almost so, of a barn owl (*Strix pratincola*). To accomplish this the artist must have had a clear conception of many of the rules of his profession.

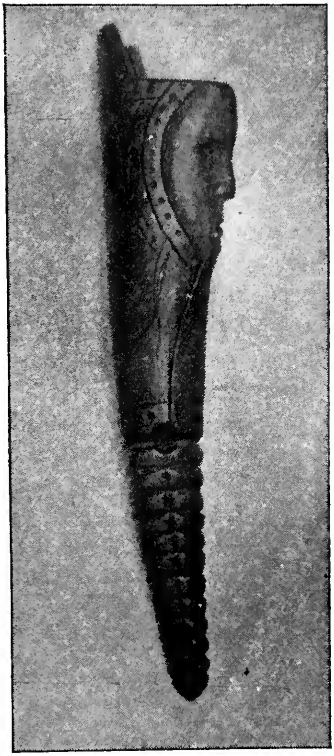

FIG. 9.—CARVED ANTLER. Delaware Indian.

Fig. 8 brings us, perhaps, to the highest point reached by the Delaware Indians in artistic effort. Here we have a portrait of an Indian, it may be, and at any rate a correct representation of the Indian countenance. This and the preceding, having metal and porcelain about them, were certainly made after European contact, unless we can suppose that the eyes originally were bits of copper, and these becoming detached, were replaced, in one case, with bits of sheet silver, and in the other with small white beads. This is not altogether improbable, and that the objects themselves really antedate the Columbian discovery. They are certainly very old.

Perhaps more striking than either of the wooden carvings is that represented in Fig. 9, which is an example of carved antler, where we have a combination of representations, all realistic, and absolutely perfect in their way. The human face is a marvel of aboriginal skill. The series of lines and dots are regular, and the faintly outlined snake's tongue is true to nature; as is also the end of the object, which represents with marked fidelity the rattle of the rattlesnake. The Indian who could make this carving had a wide range of capabilities in the line of artistic representation.

And now a word, in conclusion, with reference to pictorial representation, where many objects, and these in action, are concerned. We know how, in recent times, the Western Indian depicted with spirit a fight with other Indians or a buffalo-hunt. If, then, in prehistoric time and at the time of the continent being first peopled with Europeans, our Delaware Indian was capable of such artistic efforts as have been briefly commented upon in the preceding pages, might he not likewise have essayed in this direction also, and recorded events by the grouping of men and animals on slabs of stone? The pictured rocks on the Susquehanna show a disposition to accomplish this on a large scale; but I refer more particularly to ornament gorgets. It is scarcely safe, and certainly not logical, to decry such specimens, however startling the subject treated or artistically accomplished. Perhaps through some such pictured stone we may yet learn that the Indian was present when the last mastodon and giant elk in the valley of the Delaware bit the dust.

THE DECLINE OF BIBLIOLATRY.*

By Prof. T. H. HUXLEY.

MY memory, unfortunately, carries me back to the fourth decade of the nineteenth century, when the evangelical flood had a little abated and the tops of certain mountains were soon to appear, chiefly in the neighborhood of Oxford; but when, nevertheless, bibliolatry was rampant; when church and chapel alike proclaimed, as the oracles of God, the crude assumptions of the worst informed and, in natural sequence, the most presumptuously bigoted, of all theological schools.

In accordance with promises made on my behalf, but certainly without my authorization, I was very early taken to hear "sermons in the vulgar tongue." And vulgar enough often was the tongue in which some preacher, ignorant alike of literature, of history, of science, and even of theology, outside that patronized by his own narrow school, poured forth, from the safe intrenchment of the pulpit, invectives against those who deviated from his notion of orthodoxy. From dark allusions to

* From the Prologue to Essays upon some Controverted Questions, by T. H. Huxley, F. R. S. New York: D. Appleton & Co., 1892.

"skeptics" and "infidels," I became aware of the existence of people who trusted in carnal reason; who audaciously doubted that the world was made in six natural days, or that the deluge was universal; perhaps even went so far as to question the literal accuracy of the story of Eve's temptation, or of Balaam's ass; and, from the horror of the tones in which they were mentioned, I should have been justified in drawing the conclusion that these rash men belonged to the criminal classes. At the same time, those who were more directly responsible for providing me with the knowledge essential to the right guidance of life (and who sincerely desired to do so), imagined that they were discharging that most sacred duty by impressing upon my childish mind the necessity, on pain of reprobation in this world and damnation in the next, of accepting, in the strict and literal sense, every statement contained in the Protestant Bible. I was told to believe, and I did believe, that doubt about any of them was a sin, not less reprehensible than a moral delict. I suppose that, out of a thousand of my contemporaries, nine hundred at least had their minds systematically warped and poisoned, in the name of the God of truth, by like discipline. I am sure that, even a score of years later, those who ventured to question the exact historical accuracy of any part of the Old Testament and *a fortiori* of the Gospels, had to expect a pitiless shower of verbal missiles, to say nothing of the other disagreeable consequences which visit those who, in any way, run counter to that chaos of prejudices called public opinion.

My recollections of this time have recently been revived by the perusal of a remarkable document,* signed by as many as thirty-eight out of the twenty odd thousand clergymen of the Established Church. It does not appear that the signataries are officially accredited spokesmen of the ecclesiastical corporation to which they belong; but I feel bound to take their word for it, that they are "stewards of the Lord, who have received the Holy Ghost," and therefore to accept this memorial as evidence that, though the Evangelicism of my early days may be deposed from its place of power, though so many of the colleagues of the thirty-eight even repudiate the title of Protestants, yet the green bay tree of bibliolatry flourishes as it did sixty years ago. And, as in those good old times, whoso refuses to offer incense to the idol is held to be guilty of "a dishonor to God," imperiling his salvation.

It is to the credit of the perspicacity of the memorialists that they discern the real nature of the Controverted Question of the age. They are awake to the unquestionable fact that, if Scripture

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* Declaration on the Truth of Holy Scripture. The Times, December 18, 1891.

has been discovered "not to be worthy of unquestioning belief," faith "in the supernatural itself" is, so far, undermined. And I may congratulate myself upon such weighty confirmation of an opinion in which I have had the fortune to anticipate them. But whether it is more to the credit of the courage, than to the intelligence, of the thirty-eight that they should go on to proclaim that the canonical Scriptures of the Old and New Testaments "declare incontrovertibly the actual historical truth in all records, both of past events and of the delivery of predictions to be thereafter fulfilled," must be left to the coming generation to decide.

The interest which attaches to this singular document will, I think, be based by most thinking men, not upon what it is, but upon that of which it is a sign. It is an open secret that the memorial is put forth as a counterblast to a manifestation of opinion of a contrary character, on the part of certain members of the same ecclesiastical body, who therefore have, as I suppose, an equal right to declare themselves "stewards of the Lord and recipients of the Holy Ghost." In fact, the stream of tendency toward naturalism, the course of which I have briefly traced, has, of late years, flowed so strongly, that even the Churches have begun, I dare not say to drift, but, at any rate, to swing at their moorings. Within the pale of the Anglican establishment, I venture to doubt, whether, at this moment, there are as many thorough-going defenders of "plenary inspiration" as there were timid questioners of that doctrine half a century ago. Commentaries, sanctioned by the highest authority, give up the "actual historical truth" of the cosmogonical and diluvial narratives. University professors of deservedly high repute accept the critical decision that the Hexateuch is a compilation, in which the share of Moses, either as author or as editor, is not quite so clearly demonstrable as it might be; highly placed divines tell us that the pre-Abrahamic Scripture narratives may be ignored; that the book of Daniel may be regarded as a patriotic romance of the second century B. C.; that the words of the writer of the fourth Gospel are not always to be distinguished from those which he puts into the mouth of Jesus. Conservative but conscientious revisers decide that whole passages, some of dogmatic and some of ethical importance, are interpolations. An uneasy sense of the weakness of the dogma of Biblical infallibility seems to be at the bottom of a prevailing tendency once more to substitute the authority of the "Church" for that of the Bible. In my old age it has happened to me to be taken to task for regarding Christianity as a "religion of a book" as gravely as, in my youth, I should have been reprehended for doubting that proposition. It is a no less interesting symptom that the state Church seems more and more anxious to repudiate all complicity with the principles of the Protestant Reformation and to call itself "Anglo-Catholic." Inspiration, deprived of its old intelligible sense, is watered down into a mystification. The Scriptures are, indeed, inspired; but they contain a wholly undefined and indefinable "human element"; and this unfortunate intruder is converted into a sort of biblical whipping boy. Whatsoever scientific investigations, historical or physical, prove to be erroneous, the "human element" bears the blame; while the divine inspiration of such statements, as by their nature are out of reach of proof or disproof, is still asserted with all the vigor inspired by conscious safety from attack. Though the proposal to treat the Bible "like any other book," which caused so much scandal forty years ago, may not yet be generally accepted, and though Bishop Colenso's criticisms may still lie, formally, under ecclesiastical ban, yet the Church has not wholly turned a deaf ear to the voice of the scientific tempter; and many a coy divine, while "crying I will ne'er consent," has consented to the proposals of that scientific criticism which the memorialists renounce and denounce.

A humble layman, to whom it would seem the height of presumption to assume even the unconsidered dignity of a "steward of science," may well find this conflict of apparently equal ecclesiastical authorities perplexing—suggestive, indeed, of the wisdom of postponing attention to either until the question of precedence between them is settled. And this course will probably appear the more advisable, the more closely the fundamental position of the memorialists is examined.

No opinion of the fact or form of divine revelation, founded on literary criticism (and I suppose I may add historical or physical criticism) of the Scriptures themselves, can be admitted to interfere with the traditionary testimony of the Church, when that has been once ascertained and verified by appeal to antiquity." *

Grant that it is "the traditionary testimony of the Church" which guarantees the canonicity of each and all of the books of the Old and New Testaments. Grant also that canonicity means infallibility; yet, according to the thirty-eight, this "traditionary testimony" has to be "ascertained and verified by appeal to antiquity." But "ascertainment and verification" are purely intellectual processes, which must be conducted according to the strict rules of scientific investigation, or be self-convicted of worthlessness. Moreover, before we can set about the appeal to "antiquity," the exact sense of that usefully vague term must be

* Declaration, Article X.

defined by similar means. "Antiquity" may include any number of centuries, great or small; and whether "antiquity" is to comprise the Council of Trent, or to stop a little beyond that of Nicæa, or come to an end in the time of Irenæus, or in that of Justin Martyr, are knotty questions which can be decided, if at all, only by those critical methods which the signataries treat so cavalierly. And yet the decision of these questions is fundamental, for as the limits of the canonical Scriptures vary, so may the dogmas deducted from them require modification. Christianity is one thing, if the fourth Gospel, the Epistle to the Hebrews, the pastoral Epistles, and the Apocalypse are canonical and (by the hypothesis) infallibly true; and another thing, if they are not. As I have already said, whoso defines the canon defines the creed.

Now it is quite certain with respect to some of these books, such as the Apocalypse and the Epistle to the Hebrews, that the Eastern and the Western Church differed in opinion for centuries; and yet neither the one branch nor the other can have considered its judgment infallible, since they eventually agreed to a transaction, by which each gave up its objection to the book patronized by the other. Moreover, the "fathers" argue (in a more or less rational manner) about the canonicity of this or that book, and are by no means above producing evidence, internal and external, in favor of the opinions they advocate. In fact, imperfect as their conceptions of scientific method may be, they not infrequently used it to the best of their ability. Thus it would appear that though Science, like Nature, may be driven out with a fork, ecclesiastical or other, yet she surely comes back again. The appeal to "antiquity" is, in fact, an appeal to science, first, to define what antiquity is; secondly, to determine what "antiquity," so defined, says about canonicity; thirdly, to prove that canonicity means infallibility. And when science, largely in the shape of the abhorred "criticism," has done this, and has shown that "antiquity" used her own methods, however clumsily and imperfectly, she naturally turns round upon the appealers to "antiquity," and demands that they should show cause why, in these days, science should not resume the work they did so imperfectly, and carry it out efficiently.

But no such cause can be shown. If "antiquity" permitted Eusebius, Origen, Tertullian, Irenæus, to argue for the reception of this book into the canon and the rejection of that, upon rational grounds, "antiquity" admitted the whole principle of modern criticism. If Irenæus produces ridiculous reasons for limiting the Gospels to four, it was open to any one else to produce good reasons (if he had them) for cutting them down to three, or increasing them to five. If the Eastern branch of the Church had a right to reject the Apocalypse and accept the Epistle to the Hebrews, and the Western an equal right to accept the Apocalypse and reject the Epistle, down to the fourth century, any other branch would have an equal right, on cause shown, to reject both, or, as the Catholic Church afterward actually did, to accept both.

Thus I can not but think that the thirty-eight are hoist with their own petard. Their "appeal to antiquity" turns out to be nothing but a roundabout way of appealing to the tribunal the jurisdiction of which they affect to deny. Having rested the world of Christian supernaturalism on the elephant of biblical infallibility, and furnished the elephant with standing ground on the tortoise of "antiquity," they, like their famous Hindoo analogue, have been content to look no further; and have thereby been spared the horror of discovering that the tortoise rests on a grievously fragile construction, to a great extent the work of that very intellectual operation which they anathematize and repudiate.

Moreover, there is another point to be considered. It is of course true that a Christian Church (whether the Christian Church, or not, depends on the connotation of the definite article) existed before the Christian Scriptures; and that the infallibility of these depends upon the infallibility of the judgment of the persons who selected the books, of which they are composed, out of the mass of literature current among the early Christians. The logical acumen of Augustine showed him that the authority of the gospel he preached must rest on that of the Church to which he belonged.* But it is no less true that the Hebrew and the Septuagint versions of most, if not all, of the Old Testament books existed before the birth of Jesus of Nazareth; and that their divine authority is presupposed by, and therefore can hardly depend upon, the religious body constituted by his disciples. As everybody knows, the very conception of a "Christ" is purely Jewish. The validity of the argument from the Messianic prophecies vanishes unless their infallible authority is granted; and, as a matter of fact, whether we turn to the Gospels, the Epistles, or the writings of the early Apologists, the Jewish Scriptures are recognized as the highest court of appeal of the Christian.

The proposal to cite Christian "antiquity" as a witness to the infallibility of the Old Testament, when its own claims to authority vanish, if certain propositions contained in the Old Testament are erroneous, hardly satisfies the requirements of lay logic. It is as if a claimant to be sole legatee, under another kind of tes-

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* Ego vero evangelio non crederem, nisi ecclesiæ Catholicæ me commoveret auctoritas. —*Contra Epistolam Manichæi*, cap. v. [I would not, indeed, believe the gospel unless the authority of the Catholic Church directed me.—Editor.]

tament, should offer his assertion as sufficient evidence of the validity of the will. And, even were not such a circular, or rather rotatory, argument, that the infallibility of the Bible is testified by the infallible Church, whose infallibility is testified by the infallible Bible, too absurd for serious consideration, it remains permissible to ask, Where and when the Church, during the period of its infallibility, as limited by Anglican dogmatic necessities, has officially decreed the "actual historical truth of all records" in the Old Testament? Was Augustine heretical when he denied the actual historical truth of the record of the Creation? Father Suarez, standing on later Roman tradition, may have a right to declare that he was; but it does not lie in the mouth of those who limit their appeal to that early "antiquity," in which Augustine played so great a part, to say so.

Among the watchers of the course of the world of thought, some view with delight and some with horror the recrudescence of supernaturalism which manifests itself among us, in shapes ranged along the whole flight of steps, which, in this case, separates the sublime from the ridiculous—from Neo-Catholicism and Inner-light mysticism, at the top, to unclean things, not worthy of mention in the same breath, at the bottom. In my poor opinion, the importance of these manifestations is often greatly overestimated. The extant forms of supernaturalism have deep roots in human nature, and will undoubtedly die hard; but, in these latter days, they have to cope with an enemy whose full strength is only just beginning to be put out, and whose forces, gathering strength year by year, are hemming them round on every side. This enemy is Science, in the acceptation of systematized natural knowledge, which, during the last two centuries, has extended those methods of investigation, the worth of which is confirmed by daily appeal to Nature, to every region in which the supernatural has hitherto been recognized.

When scientific historical criticism reduced the annals of heroic Greece and of regal Rome to the level of fables; when the unity of authorship of the Iliad was successfully assailed by scientific literary criticism; when scientific physical criticism, after exploding the geocentric theory of the universe, and reducing the solar system itself to one of millions of groups of like cosmic specks, circling, at unimaginable distances from one another, through infinite space, showed the supernaturalistic theories of the duration of the earth and of life upon it to be as inadequate as those of its relative dimensions and importance had been—it needed no prophetic gift to see that, sooner or later, the Jewish and the early Christian records would be treated in the same manner; that the authorship of the Hexateuch and of the

Gospels would be as severely tested; and that the evidence in favor of the veracity of many of the statements found in the Scriptures would have to be strong indeed, if they were to be opposed to the conclusions of physical science. In point of fact, so far as I can discover, no one competent to judge of the evidential strength of these conclusions ventures now to say that the biblical accounts of the creation and of the deluge are true in the natural sense of the words of the narratives. The most the modern reconciler ventures upon is to affirm that some quite different sense may be put upon the words; and that this non-natural sense may, with a little trouble, be manipulated into some sort of non-contradiction of scientific truth.

My purpose, in the essay (XVI)* which treats of the narrative of the Deluge, was to prove, by physical criticism, that no such event as that described ever took place; to exhibit the untrustworthy character of the narrative demonstrated by literary criticism; and, finally, to account for its origin, by producing a form of those ancient legends of pagan Chaldea, from which the biblical compilation is manifestly derived. I have yet to learn that the main propositions of this essay can be seriously challenged.

In the essays (II, III) on the narrative of the Creation, I have endeavored to controvert the assertion that modern science supports, either the interpretation put upon it by Mr. Gladstone, or any interpretation which is compatible with the general sense of the narrative, quite apart from particular details. The first chapter of Genesis teaches the supernatural creation of the present forms of life; modern science teaches that they have come about by evolution. The first chapter of Genesis teaches the successive origin—firstly, of all the plants; secondly, of all the aquatic and aërial animals; thirdly, of all the terrestrial animals which now exist—during distinct intervals of time; modern science teaches that, throughout all the duration of an immensely long past, so far as we have any adequate knowledge of it (that is, as far back as the Silurian epoch), plants, aquatic, aërial, and terrestrial animals have coexisted; that the earliest known are unlike those which at present exist; and that the modern species have come into existence as the last terms of a series, the members of which have appeared one after another. Thus, far from confirming the account in Genesis, the results of modern science, so far as they go, are in principle, as in detail, hopelessly discordant with it.

Yet, if the pretensions to infallibility thus set up, not by the ancient Hebrew writings themselves, but by the ecclesiastical champions and friends from whom they may well pray to be

* [The Roman numerals in this article refer to the author's Essays upon some Controverted Questions.—Editor.]

delivered, thus shatter themselves against the rock of natural knowledge, in respect of the two most important of all events, the origin of things and the palingenesis of terrestrial life, what historical credit dare any serious thinker attach to the narratives of the fabrication of Eve, of the Fall, of the commerce between the *Bene Elohim* and the daughters of men, which lie between the creational and the diluvial legends? And, if these are to lose all historical worth, what becomes of the infallibility of those who, according to the later Scriptures, have accepted them, argued from them, and staked far-reaching dogmatic conclusions upon their historical accuracy?

It is the merest ostrich policy for contemporary ecclesiasticism to try to hide its Hexateuchal head—in the hope that the inseparable connection of its body with pre-Abrahamic legends may be overlooked. The question will still be asked, If the first nine chapters of the Pentateuch are unhistorical, how is the historical accuracy of the remainder to be guaranteed? What more intrinsic claim has the story of the Exodus, than that of the Deluge, to belief? If God did not walk in the garden of Eden, how can we be assured that he spoke from Sinai?

In some other of the following essays (IX, X, XI, XII, XIV, XV) I have endeavored to show that sober and well-founded physical and literary criticism plays no less havoc with the doctrine that the canonical Scriptures of the New Testament "declare incontrovertibly the actual historical truth in all records." We are told that the Gospels contain a true revelation of the spiritual world—a proposition which, in one sense of the word "spiritual," I should not think it necessary to dispute. But, when it is taken to signify that everything we are told about the world of spirits in these books is infallibly true; that we are bound to accept the demonology which constitutes an inseparable part of their teaching; and to profess belief in a supernaturalism as gross as that of any primitive people—it is at any rate permissible to ask why? Science may be unable to define the limits of possibility, but it can not escape from the moral obligation to weigh the evidence in favor of any alleged wonderful occurrence; and I have endeavored to show that the evidence for the Gadarene miracle is altogether worthless. We have simply three, partially discrepant, versions of a story, about the primitive form, the origin, and the authority for which we know absolutely nothing. But the evidence in favor of the Gadarene miracle is as good as that for any other.

Elsewhere I have pointed out that it is utterly beside the mark to declaim against these conclusions on the ground of their asserted tendency to deprive mankind of the consolations of the

Christian faith, and to destroy the foundations of morality; still less to brand them with the question-begging, vituperative appellation of "infidelity." The point is not whether they are wicked; but whether, from the point of view of scientific method, they are irrefragably true. If they are, they will be accepted in time, whether they are wicked or not wicked. Nature, so far as we have been able to attain to any insight into her ways, recks little about consolation, and makes for righteousness by very roundabout paths. And, at any rate, whatever may be possible for other people, it is becoming less and less possible for the man who puts his faith in scientific methods of ascertaining truth, and is accustomed to have that faith justified by daily experience, to be consciously false to his principle in any matter. But the number of such men, driven into the use of scientific methods of inquiry and taught to trust them, by their education, their daily professional and business needs, is increasing and will continually increase. The phraseology of supernaturalism may remain on men's lips, but in practice they are naturalists. The magistrate who listens with devout attention to the precept, "Thou shalt not suffer a witch to live," on Sunday, on Monday dismisses, as intrinsically absurd, a charge of bewitching a cow brought against some old woman; the superintendent of a lunatic asylum who substituted exorcism for rational modes of treatment would have but a short tenure of office; even parish clerks doubt the utility of prayers for rain, so long as the wind is in the east; and an outbreak of pestilence sends men not to the churches, but to the drains. In spite of prayers for the success of our arms and *Te Deums* for victory, our real faith is in big battalions and keeping our powder dry; in knowledge of the science of warfare; in energy, courage, and discipline. In these, as in all other practical affairs, we act on the aphorism "*Laborare est orare*";* we admit that intelligent work is the only acceptable worship; and that, whether there be a Supernature or not, our business is with Nature.

According to the London Times, Dr. Frithiof Nansen intends to start on his projected expedition to the north pole next year, and to make direct for the mouth of the Lena River in Siberia. He believes that a current sets from the Siberian coast across the pole to Greenland, as various objects have been discovered on the Greenland coast that could have got there only from Siberia or the sea north of it. Dr. Nansen expects to be away three or four years, but his ship will be provisioned for six years. His V-shaped vessel will be of about two hundred and fifty tons, will accommodate twelve men, and will be so strongly built as to be impervious to ice-nipping. Alcohol will be taken only in the medicine-chest or for food; but apparatus for providing electric light will form part of the equipment.

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* [To labor is to pray.—Editor.]

THE MARINE BIOLOGICAL LABORATORY.

By J. S. KINGSLEY.

THE little village of Woods Holl, situated on the southern shore of Massachusetts, just where that long, sandy stretch, known as Cape Cod, begins to jut from the mainland, is one of the most important spots for biological science in the whole of America. And yet how little the summer migrant knows of the place as he passes through it on his way from the mainland to the summer residences of Cottage City and Nantucket! Woods Holl has for the lover of the sea a charming situation. On the south and east is that important water-way, Vineyard Sound, through which is constantly passing a procession of vessels of all styles and sizes, from the tiny cat-boat to the large passenger steamers of the Norfolk and Savannah lines. To the west is the broad and shallow expanse of Buzzard's Bay, with the New Bedford shore now plainly visible, now appearing in that fantastic shape called by the fisherman "looming"—a kind of mirage when the coast appears doubled as in a mirror, and raised some distance above the horizon. To the southwest stretches out the long chain of the Elizabeth Islands, which possess no little interest. They together form the town of Gosnold, named for that old explorer who in 1602 built his fort upon the westernmost island, Cuttyhunk, traces of which are said to remain to the present day. These Elizabeth Isles have retained the musical names which the Indians gave them, and the students who yearly visit Woods Holl have their struggles with the rhyme—

"Naushon, Nashuena,
Nonamesset, Uncatena,
Weepecket, Pasquenese,
Cuttyhunk and Penikese"—

which embodies the names of the eight.

The channels between the islands are known as "gutters," if shallow; "holes," if broad and deep. Thus, in one place is Quick's Hole, in another Robinson's Hole, while between Nonamesset and the mainland is the dangerous passage of Wood's Hole, whose rocks have proved the wreck of many a vessel and which gives the name to the adjacent village, the spelling of which has for some unexplained reason been changed by the Post-Office Department to Holl.*

* [The First Report of the United States Board on Geographic Names has the following explanation of this change: "The name which was originally Wood's Hole was changed several years ago by the summer residents of the place to Woods Holl."—EDITOR.]

The village itself is absolutely without business, except the daily shipment of fresh fish to the Boston and New York markets. In years long gone by, like the neighboring seaports, it was interested in the whale fisheries, and a recollection of those oily days still remains in the old stone candle factory where the spermaceti was made into wax candles. Later the Pacific Guano Company established here its extensive works, to which the phosphate rock of the Carolina rivers was brought, pulverized, treated with sulphuric acid, and converted into fertilizers for the farmer. But a few years ago the company failed, and the property has all been sold.

The United States has considerable interests here. There is the lighthouse wharf, where the supplies for the whole district are kept. To this wharf every buoy and channel-mark is brought each year to receive its coat of preservative copper paint; and here is almost always to be seen a reserve light-ship to replace any that may be injured upon the many adjacent shoals. The revenue marine has also its wharf here, where its steamers obtain their supplies of coal and the like. Here, too, is the place where one leaves the dusty cars of the Old Colony Railway for the cool and comfortable steamers for Cottage City and Nantucket. Not these, however, but rather the scientific aspects of the place, interest us at present.

There is no place like the sea-shore for the student of natural history. On the one hand, we can turn to the fields and streams, and find there essentially the same animals and plants which occur a hundred miles inland; on the other, we have the wondrous wealth of life of the ocean, so rich as to almost surpass belief. This richness is of two kinds: First, there is the wealth of numbers, a wealth which is far beyond that of any fresh-water expanse; and, second, the astonishing variety of forms. Whole groups of animals are abundant in the ocean which are absolutely without representatives in our rivers and lakes. Sea anemones and corals, star-fishes and sea-urchins are wholly unknown in fresh water, while thousands of other marine forms have but a few insignificant representatives in ponds and streams.

Nor is this richness either of forms or of individuals the only advantage the sea offers the student. The marine animals often have a greatly different history from their fresh-water relatives. One of the most important studies of the modern naturalist is that which traces every phase of growth of an animal from the time the egg is laid until the adult condition is reached. It is hardly necessary to say that the theory of evolution is no longer a question for discussion with him. He accepts the principle and makes it the key-note of all his investigations. He is now trying to ascertain the various lines of descent, rather than to test the truth of the theory. One of the laws of evolution is that animals, in their growth from the egg to the adult, pass through conditions which represent, more or less clearly, the different stages through which the line of descent has come. Thus, the existence of rudimentary gills, with the cartilages and blood-vessels proper to gills, in the human embryo, is taken as an indication that at one time the ancestor had gills which were functional—in other words, that man has descended from a fish-like form. There are, however, great differences in the completeness with which this record of ancestral history has been preserved. Speaking generally, more features have been dropped by the fresh-water and terrestrial forms than by those of the sea. In the latter there frequently hatches from the egg a larva which bears not the slightest resemblance to the adult: the young sea-urchin shows not a feature of the spiny creature we find in the holes in the rocks; and these changes—metamorphoses they are called—are fraught with interest and instruction to the student who goes deeper than ascertaining the mere name of the form he collects. So we can see that, if the ocean offer such advantages, a laboratory for the study of Nature should be on the shore.

Not all places on the coast are equally suitable for study. At one there is nothing but sand; another has rocks and no sand or mud; a third has the water vitiated by the mouth of some river constantly pouring in fresh water, which makes the neighboring ocean brackish; a fourth is contaminated by the sewage of a large city. All these conditions conspire to make the region poor in life. The proper place for our studies must have rocky points; stretches of mud and sand exposed at low tide; currents to bring constantly the pure water of the sea; and such localities are not abundant. It was over twenty years ago that the late Professor Spencer F. Baird, of the Smithsonian Institution, recognized the advantages of Woods Holl, not only for the investigation of the problems of pure science, but for the study of the many questions of more economic importance connected with the supply of food-fishes of the country. So, year after year, he and his assistants came here and worked through the summer months. Some made studies of the fish of the region; others collected the other forms of life, for among these we must seek the food of the fishes; still others traced the life-histories of the injurious as well as of the valuable forms; while still others worked at the problems of artificial hatching and the like. As the work went on it outgrew the limited quarters afforded by the barn-like building on the lighthouse wharf, and so Congress granted the money for the present buildings, the finest for their purposes of any in the world.

These buildings were completed shortly before the death of Professor Baird. On the one side is the Dormitory and Mess Hall,

Fig. 1.—Buildings of the United States Fish Commission, at Woods Holl, Mass. Left, the Laboratory; center, the Engine House; right, the Dormitory. In the background at the right is the building of the Marine Biological Laboratory.

for accommodations are scarce in Woods Holl, and students can not pay summer-hotel prices. On the other is the admirably equipped Laboratory. On the ground-floor is the fish-hatching room, where each year millions of cod, lobsters, and other valuable animals are carried through the critical period of their existence before being turned into the ocean to shift for themselves. On the same floor are the public aquaria stocked with the most interesting and most attractive animals of the region. The second floor is devoted to laboratories for students and offices for the clerical force. Between the dormitory and the laboratory is the pumping station which forces a constant stream of salt water through the aquaria.

Attracted, not only by the natural advantages of the place, but also by the advantages to be gained by proximity to such an institution as the Fish Commission, the Marine Biological Laboratory was located here. This institution is an evolution, and its embryonic history possesses a certain interest.

For several years, Professor Alpheus Hyatt, of the Boston Society of Natural History, with some of his pupils, spent the summer months in natural history studies at the quaint little fishing village of Annisquam, on the north shore of Cape Ann. The facilities afforded, limited as they were, were highly appreciated by those who came, and more than could be accommodated desired each year to profit by them.

One of the many Boston "isms" is its Woman's Education Association, and a world of good it has done. If any scheme can be shown to promise good results for the education of women, the society will see that the money and all that is necessary are soon forthcoming. So with the humble beginnings at Annisquam; if women could be accommodated, the problem could be easily solved. So the Association provided the money, a building was hired and equipped with the absolutely necessary furniture and apparatus, and on June 15, 1881, the first student began his work in the Annisquam Laboratory. For six years this institution was kept up; a hundred students worked there with scalpel and microscope, and the laboratory fully demonstrated its *raison d'être*.

It is a principle of the Woman's Education Association to carry its projects through the experimental stage, but no further. If, then, they have shown their necessity or utility, the Association takes the necessary steps to put the institution upon an independent footing. So with the Annisquam Laboratory. It supplied a want, and must be made permanent. As a result of several meetings in Boston, the Marine Biological Laboratory was incorporated in the spring of 1888, and to it was transferred all the property, etc., of its Annisquam predecessor.

The new was, however, to be greater than the old. At Annis-

Fig. 2.—Building of the Marine Biological Laboratory, Woods Holl, Mass.

quam instruction had been almost the sole function, and no provision was made for investigation. In the new institution research was to be made prominent. At Annisquam scarce twenty students could be accommodated; its successor must provide for at least fifty. Naturally, the question of situation was a serious one. Not a single place on the whole Atlantic coast, from Eastport to Newport, fulfilled all requirements; but Woods Holl seemed the best of all, and hence the result already indicated.

Money was raised, land near the Fish Commission building was purchased, and a two-story building twenty-nine by sixty-three and a half feet was erected and equipped in time for the summer session of 1888. This was enlarged two years later by an addition measuring twenty by forty feet; and this spring a new addition is being made, equal in size to the original structure. This affords some evidence of the growth of the laboratory, and of the constantly increasing demands upon it for space. This growth is also shown in another way. In 1888, seventeen enjoyed its facilities; in 1889, there was a jump to forty-four; in 1890, forty-seven; while in 1891 there was another jump to seventy-one. In these numbers are included both pupils and instructors, for all are students. Those who do the teaching are always engaged in investigation, and their researches are carried on in the moments snatched from the pupils proper. In 1888 there were but two instructors; for 1892, eight are announced.

The laboratory has been extremely fortunate in its head. Ever since its organization Professor Charles Otis Whitman, of Clark University—recently appointed to the new Chicago University—has served as Director, and not a little of the success of the laboratory is due to his efforts and his plans for its development. The scope of the work as announced for this summer shows how far the laboratory has advanced along the lines laid down for it.

As already mentioned, two very distinct functions are recognized: the laboratory is at once a center for the advancement and for the diffusion of knowledge; it is a school for teaching and an institute for research; and accordingly the students who annually attend are divided by a distinct line into pupils and investigators. In the first category come those whose acquaintance with Nature and with the methods of finding out her secrets, is slight. Before they can engage in original research they must have a solid foundation of fact, and facility in the use of the naturalist's instruments. So they dissect and study under the microscope a selected series of animals and plants which may exhibit broadly the different types of structure in the living world. In this class, to which the ground-floor of the laboratory is given up, the pupil is constantly under the eye of the instructor, who endeavors to teach him how to use the microscope and its accessories, how to dissect, and, most important of all, how to interpret what he sees. From the animals studied, the young naturalist obtains a broad knowledge of the general structure which occurs in the greater groups of the animal and vegetable worlds, which can be used as a basis for comparison in future work. In giving the necessary instruction, those in charge are continually trying to impress upon the student the necessity of accuracy and the love of truth, and to give him a clear idea of the great principle of homology, which is the very center and soul of modern morphological work.

A word or two may be necessary to explain exactly what this means. Two organs are said to be homologous when they have the same general structure, no matter how diverse may be the uses to which they are put. Thus, for example, if we dissect the arm of a man and the wing of a chicken, we shall find in each similar bones, muscles, blood-vessels, and nerves; in short, a broadly identical structure—they are homologous organs, and yet how different are their functions! On the other hand, when we study the wing of a butterfly or of a bee, we find in it no bones, no muscles, no nerves; and yet it, like the wing of a bird, is an organ of flight. The resemblances are those of analogy; homology is lacking. In these examples the distinctions are evident, but this is not always the case, yet the principle is equally important in all.

These elementary students occupy the ground-floor of the laboratory. Each has his regular seat at the laboratory tables, a locker for his instruments, and his set of reagents and supplies. In the center of the room are the aquaria, where animals for dissection and study are kept. Here he may work "from early dawn to dewy eve," and later if he (or she) desire.

The second floor is dedicated to investigation, and the students here may be divided into two groups. In the first are those who have pursued a course of study essentially equivalent to that of the pupils on the lower floor, and who wish to begin original investigation. It is not an easy problem for the beginner to find out what questions are important to be solved, and even less easy is it for him to attempt their solution. He needs assistance at first at almost every step. For such persons twenty places are provided. The instructors in charge select some problem which needs solution, and which, at the same time, is not too difficult for the beginner, and which, further, will give experience in technique and method of study. They map out the investigation, and watch the embryo investigator in his struggles. Every step in its solution is accompanied with criticism or suggestion, and, when difficulties arise, either of technique or interpretation, the instructor is at hand to smooth away the trouble.

For those who have passed this preliminary training, and who are ready to carry on investigation, twenty-four private rooms on the second floor are set aside. Here, in privacy and in quiet, undisturbed by others, each can solve his problems. In each room is an aquarium to keep the animals or plants, while the table and shelves are supplied with the necessary books, reagents, and glassware. All who have carried on investigations after the modern methods of zoölogy and botany realize that rapidity is incompatible with good work. A thorough piece of investigation can not be completed in a few weeks; and yet over thirty papers have been published, or are now in press, as the results of the investigations carried on in those private rooms. No laboratory connected with any college or university in the country can show equal productiveness.

Fig. 3.—A Bit of the Students' Laboratory, Woods Holl, Mass.

In both upper and lower laboratories, among both beginners and investigators, some are working at zoölogical, others at botanical subjects; while this year, for the first time, physiology is to be included in the work done. Material for study is abundant. Besides row-boats, which are available for shore collecting, the laboratory has a sail-boat and also a Burgess-built steam-launch, the Sagitta, which has proved itself the fastest boat in the region. This is daily in use. Now it goes out on a dredging trip in the sound; yesterday it made a trip to Cuttyhunk or Gay Head for lobsters; this morning it made the round of the fish-pounds along the coast for sharks and strange fish; to-morrow it will take a party to Naushon for worms and sea-cucumbers. So it goes, day after day, constantly bringing material for the workers in the laboratory. At night another kind of collecting is tried. Many of the smaller animals and the larvæ of the larger kinds come to the surface of the sea when the sky is dark and the water calm. Then the naturalist, with a net of gauze, skims the surface of the sea, and catches the life found there. The results of such surface-skimming are wonderful, and no one who has never seen the operation would begin to imagine the richness of the catch. And then, how quickly it dies! At night there are millions of animals in the dishes into which the tow is poured; in the morning all are dead. So the skimmings must be studied soon after they are taken, if one wishes to utilize them.

The instruction given at the laboratory is largely personal. Each student is carefully watched by the instructors, and naturally the beginners receive more attention than those in the upper laboratory. They also have their daily lectures upon the general principles of zoölogy and botany. There are frequently other laboratory lectures upon subjects of more general scientific interest. These are given in the evening by the laboratory staff or by visiting naturalists, and no lecture course in the country can boast of such subjects treated by such masters. Naturally, they are appreciated by all, and the little lecture-room is always crowded when they occur. The lectures for 1890 have been issued in book-form, and the volume has been highly praised by the scientific press of the world.

To the student of to-day books are almost as important as specimens. He needs them to show him not only what has already been found out, so that he need not waste his time in duplicating the labors of some foreign naturalist, but also to show him the structure or development in allied forms, so that with the larger array of facts he can have a basis for interpretation of the meaning of his own discoveries. So the laboratory has gathered together a small library. Most of the publishing naturalists of America have given extra copies of their papers, and a generous friend has supplied the means for the purchase of complete sets of several of the most important European periodicals.

Although started in Boston, the Marine Biological Laboratory is a national rather than a local institution. A student from California is as warmly welcomed as one from the immediate neighborhood. In its four years students have come from twenty-two States, from Canada and Japan. Philadelphia has sent more students than Boston; while Dakota, Nebraska, Colorado, California, and Kansas have been represented. The fees charged are, for the lower laboratory, thirty dollars; for the upper, fifty dollars, for the season. These fees fall far short of paying the actual running expenses, and yet every outgo is reduced as far as is compatible with first-class results. So every year the trustees have the problem of meeting the deficiency. So far it has been successfully solved, but it means a continuous struggle. Various plans have been suggested; the most promising is the following: That different colleges and universities endow the private rooms with a hundred dollars a year, and by virtue of this payment have the right to nominate the annual occupant.

Such in outline is the Marine Biological Laboratory as it exists to-day; but it is far from being the institution that its friends

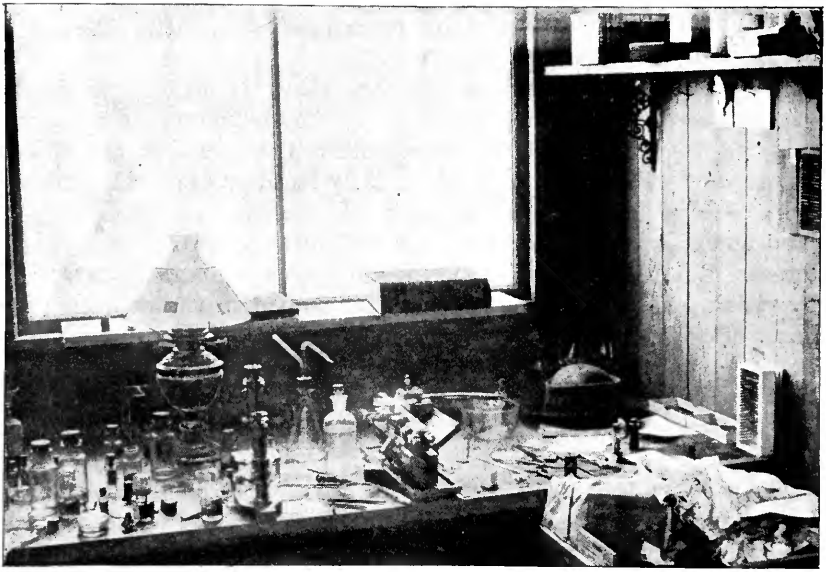

Fig. 4.—A Private Room, Marine Biological Laboratory.

wish it to be. It has developed about as far as possible in the line of a school of instruction, but as a center of investigation there is a chance for enormous growth, and for development in that direction the plans are already well thought out, but as yet the necessary money is lacking.

Only a few years ago, when the student wished to investigate marine life, he must take his laboratory with him and depend for quarters upon a room in a fish-house or the like near the shore. That was the way in which Johannes Müller worked in Europe, and the way in which Agassiz studied on our own coast. Some fifteen or twenty years ago the change began, and sea-side laboratories were erected. The best known of these to-day is the celebrated Zoölogical Station at Naples, established by Dr. Dohrn, to which students flock from every quarter of the world. In its appointments it is almost perfect, while in its results it takes the first rank of all the institutions of investigation in existence. Since its establishment other laboratories modeled after it have been founded in all quarters of the globe—Australia, Japan, and Java not being behind the rest. In America the station established by Mr. Alexander Agassiz at Newport is exclusively for investigation, but it is only open to invited guests of its founder. It was a part of the plan of the late Professor Baird to make the Woods Holl station of the United States Fish Commission a center of pure science as well as a laboratory for the solution of the more economic problems connected with the food-fishes, and it has been such. The scientific results published by the students who have availed themselves of the facilities afforded have been very considerable. Still, it is evident that in a Government institution research must ever be subordinate to the more practical questions. The people can pay for that which will put dollars in their pockets, but study for study's sake is something that the average politician can not appreciate. At present, at least, pure research must be supported by private means rather than by Government grant.

The Marine Biological Laboratory has the foundation upon which the ideal laboratory can be built. Its board of trustees includes some of the most prominent zoölogists in America, who can be expected to guide it in the most profitable directions. It has already purchased land for future growth. The desire now is that upon this land shall be erected a building which can be kept open all the year, instead of some three or four months in summer. Here there shall be a force of paid investigators through the year, working at the many problems connected with the living world. On the other hand, it will at the same time prove an annex to every progressive college and university in the land, for to it in summer both professors and students can freely come for study and to collect the materials for the winter classes. It will need a large library for reference, and funds for the publication of the results worked out within its walls.

Such an institution can not live from hand to mouth, but it must have an endowment sufficient to pay all running expenses, salaries, and the like. It offers to the future benefactor much in return. To found a college or university to-day requires an enormous fortune; a fraction of that sum would establish a biological station the best in the world. Nowhere in educational lines can such great results be expected as here. We have enough colleges and universities; institutions primarily for research are as yet lacking; yet what honor they would reflect upon the man far-sighted and public-spirited enough to give them the means of existence!

INFECTIOUS DISEASES. CAUSATION AND IMMUNITY.*

By GEORGE M. STERNBERG, M. D.,
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CERTAINLY, from a scientific point of view, no question in medicine is more important than that which relates to the causation of disease. An accurate knowledge of the specific etiological agents concerned in the production of specific infectious diseases forms the very basis of scientific medicine; and, as you all know, researches which have been made during the past thirty years have given us this accurate knowledge for a considerable number of these diseases. I say thirty years, in order to include the researches of Davaine upon anthrax; but, as a matter of fact, the principal portion of our knowledge relating to specific disease-germs has been acquired during the past decade.

As an introduction, a brief historical review of the progress of our knowledge will perhaps not be out of place. But first I must call your attention to the fact that this progress has been made possible by certain improvements in methods of research, and especially by the following: first, the use of a cotton filter to exclude atmospheric organisms from our culture media (Schröder and Von Dusch, 1854); second, the sterilization of culture media by heat (methods perfected by Pasteur, Koch, and others); third, the use of aniline dyes as staining agents (first recommended by Weigert in 1877); fourth, the introduction of solid culture media, and the "plate method" for obtaining pure cultures (by Koch in 1881); fifth, the perfection of methods for cultivating anaërobic bacteria. I have already referred to the researches of Davaine relating to the disease of cattle and sheep known as anthrax. Having ascertained that the blood of an infected animal constantly contained a rod-shaped micro-organism, and that the smallest quantity of this blood inoculated into a susceptible animal gave rise to the disease and caused its death, Davaine, in 1863, boldly announced his belief that the bacillus was the specific etiological agent in this disease. The experiments of Davaine were not, however, generally accepted as conclusive, because, in inoculating an animal with blood containing the bacillus, the living micro-organism was associated with material from the body of the diseased animal. This objection was subsequently removed by the experiments of Pasteur, Koch, and many others with pure cultures of the bacillus. These were shown to have the same pathogenic effects as had been obtained in inoculation experiments with the

* Address in Medicine, delivered at Yale University, June 28, 1892.

blood of an infected animal. To-day no one questions the etiological relation of *Bacillus anthracis* to the disease anthrax. And this bacillus has served for innumerable experiments relating to the solution of a variety of questions in pathology and preventive medicine. Among these we may mention the following, each of which has an extended literature: attenuation of virulence; protective inoculation of susceptible animals; hereditary transmission of protection; passage of pathogenic bacteria through the placenta, from the mother to the fœtus; explanation of acquired immunity; comparative value of germicidal agents and of antiseptics; conditions governing spore formation, etc.

Proceeding with our historical review: In 1873, Obermeier, a German physician, announced the discovery, in the blood of patients suffering from relapsing fever, of a minute, spiral, actively motile micro-organism—the *Spirochæte Obermeieri*—which is now generally recognized as the specific infectious agent in this disease. Recently (1890) a spirillum closely resembling the relapsing-fever spirillum has been discovered by Sakharoff, a Russian investigator, in the blood of geese. The investigations of the author named show that it is the cause of a fatal epidemic disease which occasionally prevails among geese in certain swampy localities in Caucasia.

In 1879 Hansen reported the discovery of bacilli in the cells of leprous tubercles. Subsequent researches have shown that this bacillus is constantly associated with leprosy, and presumably bears an etiological relation to the disease.

In the same year (1879) Neisser discovered the "gonococcus." The bacillus of typhoid fever was first observed by Eberth, and independently by Koch, in 1880, but it was not until 1884 that Gaffky's important researches relating to this bacillus were published. It is now well established that this bacillus is constantly found in the spleen and intestinal glands involved in cases of typhoid fever; and pathologists have generally accepted it as the specific etiological agent in this disease. We can scarcely doubt the correctness of this conclusion, although it must be admitted that no satisfactory experimental demonstration of the fact has yet been made, inasmuch as none of the lower animals are subject to the disease as it occurs in man, and inoculations with pure cultures do not give rise to identical morbid phenomena. Since the discovery of the typhoid bacillus very numerous researches have been made to determine in an exact manner its biological characters, its resistance to germicidal agents, the duration of its vitality in drinking-water and in the soil, its presence in water the ingestion of which has been suspected of causing typhoid fever in man, etc. As to the results of these investigations we may say, in brief, that it has been shown that the bacillus as obtained from the spleen of typhoid cadavers varies somewhat in different cases; that very similar bacilli may be obtained from waters contaminated by sewage, etc., which differ from the typhoid bacillus in certain characters of growth, and yet resemble it so closely that it is still uncertain whether they are to be considered distinct species or only varieties of the typhoid bacillus; that the character which was at first supposed to distinguish the typhoid bacillus from all others—viz., its invisible growth upon potato—has proved to be unreliable, inasmuch as certain other bacteria have been shown to have a like invisible growth, and under certain circumstances the typhoid bacillus may form a visible growth on potato. However, in spite of these difficulties in differentiating the typhoid bacillus from nearly allied bacteria found in water or in the dejecta of man and the lower animals, there is good reason to believe that the bacillus of Eberth, of Koch, and of Gaffky is the veritable etiological agent in the widely spread endemic and sometimes epidemic disease known as typhoid fever. But in admitting this we must admit that the bacillus itself is widely distributed, and that an attack of typhoid fever does not necessarily follow its introduction into the alimentary canal of man by means of contaminated water or milk. Other secondary causes, no doubt, often determine the question of infection. Among these we may mention individual susceptibility; exposure to agencies which reduce the vital resisting power, such as sewer-gas poisoning; the quantity and the virulence of the typhoid germs ingested; the state of the digestive function, etc.

In 1880 the present writer discovered the important pathogenic micrococcus which is now generally recognized as the usual cause of croupous pneumonia. This I now call *Micrococcus pneumoniæ crouposæ*. The German bacteriologists usually speak of it as the *Diplococcus pneumoniæ*. I first discovered this micrococcus in the blood of rabbits inoculated with a few drops of my own saliva; and subsequent researches have shown that it is found in the saliva of healthy individuals in various parts of the world. This fact may at first view appear to be opposed to the statement that it is the usual cause of croupous pneumonia, especially as I have never myself suffered from this disease, although for several years I frequently demonstrated the presence of this micrococcus in my salivary secretions. But, as in the case of the typhoid bacillus and several other widely distributed bacteria, while accepting, upon experimental evidence, the etiological relation of the specific micro-organism, we are also obliged to admit the essential relation of predisposing or exciting causes in the development of an attack of the disease. In this connection I quote from a paper of my own, published in 1885:

The constant presence of this micrococcus in the buccal secretions of healthy persons indicates that some other factor is required for the development of an attack of pneumonia; and it seems probable that this other factor acts by reducing the vital resisting power of the pulmonary tissues, and thus making them vulnerable to the attacks of the microbe. This supposition enables us to account for the development of the numerous cases of pneumonia which can not be traced to infection from without. The germ being always present, auto-infection is liable to occur when, from alcoholism, sewer-gas poisoning, crowd-poisoning, or any other depressing agency, the vitality of the tissues is reduced below the resisting point. We may suppose, also, that a reflex vaso-motor paralysis, affecting a single lobe of the lung, for example, and induced by exposure to cold, may so reduce the resisting power of the pulmonary tissues as to permit this micrococcus to produce its characteristic effects. Again, we may suppose that a person, whose vital resisting power is reduced by any of the causes mentioned, may be attacked by pneumonia from external infection with material containing a pathogenic variety of the micrococcus having a potency, permanent or acquired, greater than that possessed by the same organism in normal buccal secretions."

Investigations made since the above was written show that this micrococcus does vary greatly in its pathogenic power when obtained from different sources, and that virulent cultures obtained from the blood of inoculated animals become attenuated when they are kept for a short time. This, indeed, is a general rule as regards the best-known pathogenic bacteria; which usually acquire increased virulence when cultivated in the bodies of susceptible animals, and become attenuated as regards their pathogenic potency when they are cultivated for a certain length of time in artificial media. My own experiments with pneumonic sputum were made in January, 1885, and led me to the identification of the oval coccus, commonly in pairs, which is found in this material, with the coccus which I had previously found in my own saliva (September, 1880), and which was subsequently the object of extended experimental researches made by me in 1881–1884.

In my paper read before the Pathological Society of Philadelphia, in April, 1885, I say: "It seems extremely probable that this micrococcus is concerned in the etiology of croupous pneumonia. . . . But this can not be considered as definitely established by the experiments which have thus far been made upon the lower animals." The extended researches of Fränkel, Weichselbaum, Netter, Gamaleïa, G. and F. Klemperer, and others, which have been published since, have fully established the etiological *rôle* of the micrococcus in question.

In 1882 Fehleisen isolated the so-called streptococcus of erysipelas and proved by experiment that it is the etiological agent in the production of erysipelatous inflammations. At a later date (1884) Rosenbach isolated the micro-organisms commonly concerned in traumatic infections and in the production of acute abscesses. Among these was a streptococcus, called by him *Strep-*

tococcus pyogenes, which is probably identical with *Streptococcus erysipelatos* of Fehleisen, although some bacteriologists still insist that slight differences exist in the mode of growth in certain culture media which justify the view that they are well-defined varieties if not distinct species. I am of the opinion that the streptococcus obtained from erysipelatous inflammations is identical with the streptococcus of pus; and we have ample evidence that the pathogenic power of this micro-organism differs as a result of conditions relating to its environment. In artificial culture media it becomes more or less attenuated, but when obtained from the tissues invaded in erysipelas, or in puerperal septicæmia, it has an increased virulence. Like the micrococcus of pneumonia, this is a widely distributed micro-organism; it has frequently been obtained in cultures from the surface of the body or from exposed mucous membranes of healthy persons. This is also true of the other pus cocci concerned in traumatic infections. And, in the light of our present knowledge, it appears that erysipelas, wound infection, abscess formation, etc., do not depend alone upon the presence of the specific etiological agents which induce such localized infectious processes, but also upon predisposing and secondary causes relating to the infected individual, as well as upon the origin and virulence of the pathogenic micro-organism. Thus the *Streptococcus pyogenes* from a case of erysipelas or of puerperal septicæmia introduced into a recent wound upon a healthy person would be likely to cause a severe and possibly fatal infection, while an attenuated culture of the same would perhaps give rise to no symptoms, or at most to slight local inflammation. On the other hand, if the vital resisting power of the individual is reduced by previous ill-health, by insufficient food, by sewer-gas poisoning, crowd-poisoning, etc., an attenuated variety of *Streptococcus pyogenes* may perhaps give rise to an erysipelatous inflammation, or to an acute abscess, if introduced by accident into an open wound. Again, in contused and lacerated wounds the vital resisting power of the tissues is diminished; and wound infection is likely to occur from the accidental introduction of the pus cocci, which lead a saprophytic existence upon the surface of the body and exposed mucous membranes, where under ordinary circumstances they are quite harmless. Secondary infections due to these now well-known pyogenic micrococci are not infrequent as sequelæ to the specific infectious diseases, such as scarlet fever, yellow fever, etc.

In 1882 Koch published his famous discovery of the tubercle bacillus. This will always rank as one of the most important events in the history of medicine, and as a notable triumph of well-directed scientific research. The proof that the bacillus referred to is the specific cause of tuberculous processes and that tuberculosis is an infectious disease, was contained in Koch's original memoir announcing his discovery. Investigations made since have fully confirmed Koch's conclusions in all important particulars. In order to show you the interest taken by bacteriologists and pathologists in all that relates to the tubercle bacillus and the effects of its pathogenic action, I have referred to the Jahresbericht of Baumgarten, for the year 1890, which gives abstracts of all original memoirs in this field of research. The total number of papers referred to, published during the year mentioned, is one hundred and thirty-five. By far the greater number are published in German and French journals, but the literature includes a certain number of memoirs published in Russia, in Italy, in Hungary, in Sweden, and in the United States.

Another important discovery, made in 1882, is that of the bacillus of glanders, by Löffler and Schutz.

Koch published his discovery of the cholera spirillum ("comma bacillus") in 1884.

The same year (1884) Löffler discovered the diphtheria bacillus. Subsequent researches have not only established the etiological relation of this bacillus to the disease known as diphtheria, but have given us an exact knowledge of its biological characters and pathogenic action, as tested upon lower animals.

The tetanus bacillus was discovered in 1884 by Nicolaier, a student in the laboratory of Prof. Flügge, of Göttingen. That this bacillus is the cause of tetanus in man has been demonstrated by the subsequent researches of numerous investigators.

So far as human pathology is concerned, no important pathogenic micro-organism has been discovered since the date last mentioned (1884) until the present year. After numerous unsuccessful researches by competent bacteriologists, a bacillus has been discovered by Pfeiffer, of Berlin, and independently by Canon, which there is good reason to believe is the specific cause of epidemic influenza.

We have, also, a recent announcement, by Canon, of the discovery of a minute bacillus in the blood of patients suffering with measles, but the etiological relation of this bacillus has not been established, and additional researches will be required before we can properly estimate the value of Canon's alleged discovery.

The brief historical review which we have made shows that the etiology of a considerable number of infectious diseases has been determined by the researches of bacteriologists, but it also shows that other important diseases of this class are not included in this list.

Up to the present date no satisfactory demonstration of the specific infectious agent has been made in any one of the eruptive fevers; and in yellow fever, my own extended researches have failed to clear up the etiology of the disease. In the last-mentioned disease, there are excellent *a priori* reasons for believing that a living micro-organism of some kind is the essential etiological factor; but this hypothetical germ has eluded all researches. Possibly it belongs to an entirely different class of micro-organisms, as is the case with the blood parasite which is now recognized as the cause of the malarial fevers.

Having thus briefly reviewed the progress of our knowledge relating to the etiology of infectious diseases, I desire to call your attention to the question of acquired immunity from these diseases.

No questions in general biology are more interesting, or more important from a practical point of view, than those which relate to the susceptibility of certain animals to the pathogenic action of certain species of bacteria, and the immunity, natural or acquired, from such pathogenic action which is possessed by other animals. It has long been known that certain infectious diseases, now demonstrated to be of bacterial origin, prevail only or principally among animals of a single species. Thus, typhoid fever, cholera, and relapsing fever are diseases of man, and the lower animals do not suffer from them when they are prevailing as an epidemic. On the other hand, man has a natural immunity from many of the infectious diseases of the lower animals, and diseases of this class which prevail among animals are frequently limited to a single species. Again, several species, including man, may be susceptible to a disease, while other animals have a natural immunity from it. Thus, tuberculosis is common to man, to cattle, to apes, and to the small herbivorous animals, while the carnivora are, as a rule, immune; anthrax may be communicated by inoculation to man, to cattle, to sheep, to guinea-pigs, rabbits, and mice, but the rat, the dog, carnivorous animals, and birds are generally immune; glanders, which is essentially a disease of the equine genus, may be communicated to man, to the guinea-pig, and to field-mice, while house-mice, rabbits, cattle, and swine are to a great extent immune.

In addition to this general race immunity or susceptibility, we have individual differences in susceptibility or resistance to the action of pathogenic bacteria, which may be either natural or acquired. As a rule, *young animals are more susceptible than older ones.* Thus in man the young are especially susceptible to scarlet fever, whooping-cough, and other "children's diseases," and after forty years of age the susceptibility to tubercular infection is very much diminished. Among the lower animals it is a matter of common laboratory experience that the very young of a susceptible species may be infected when inoculated with an "attenuated culture" which older animals of the same species are able to resist.

Considerable differences as to susceptibility may also exist among adults of the same species. In man these differences in individual susceptibility to infectious diseases are frequently manifested. Of a number of persons exposed to infection in the same way, some may escape entirely, while others have attacks differing in severity and duration. In our experiments upon the lower animals we constantly meet with similar results, some individuals proving to be exceptionally resistant. Exceptional susceptibility or immunity may be to some extent a family characteristic, or one of race. Thus, the negro race is decidedly less subject to yellow fever than the white race, and this disease is more fatal among the fair-skinned races of the north of Europe than among the Latin races living in tropical or subtropical regions. On the other hand, small-pox appears to be exceptionally fatal among negroes and dark-skinned races generally. A very remarkable instance of race immunity is that of Algerian sheep against anthrax, a disease which is very fatal to other sheep.

The essential difference between a susceptible and immune animal depends upon the fact that in one the pathogenic germ, when introduced by accident or experimental inoculation, multiplies and invades the tissues or the blood, where, by reason of its nutritive requirements and toxic products, it produces changes in the tissues and fluids of the body inconsistent with the vital requirements of the infected animal; while in the immune animal multiplication does not occur or is restricted to a local invasion of limited extent, and in which after a time the resources of Nature suffice to destroy the parasitic invader.

Now, the question is, Upon what does this essential difference depend? Evidently upon conditions favorable or unfavorable to the development of the pathogenic germ; or upon its destruction by some active agent present in the tissues or fluids of the body of the immune animal; or upon a neutralization of its toxic products by some substance present in the body of the animal which survives infection. The composition of the body fluids, and especially their reaction, is probably a determining factor in some instances. Thus, Behring has ascribed the failure of the anthrax bacillus to develop in the white rat, which possesses a remarkable immunity against anthrax, to the highly alkaline reaction of the blood and tissue juices of this animal. Behring claims to have obtained experimental proof of the truth of this explanation by feeding white rats on an exclusive vegetable diet, or by adding acid phosphate of lime to their food, by which means this excessive alkalinity of the blood is diminished. Rats so treated are said to lose their natural immunity, and to die as a result of inoculation with virulent cultures of the anthrax bacillus.

The recent experiments of Nuttall, Behring, Buchner, and others have established the fact that recently drawn blood of various animals possesses decided germicidal power, and Buchner has shown that this property belongs to the fluid part of the blood and not to its cellular elements. This power to kill bacteria is destroyed by heat, and is lost when the blood has been kept for a considerable time, but it is not neutralized by freezing. Further, this power to destroy bacteria differs greatly for different species, being very decided in the case of certain pathogenic bacteria, less so for others, and absent in the case of certain common saprophytes.

In the infectious diseases of man involving the system generally, a single attack commonly confers immunity from subsequent attacks. This is true of the eruptive fevers, of typhoid fever, of yellow fever, of mumps, of whooping-cough, and, to some extent at least, of syphilis. But it seems not to be the case in epidemic influenza (*la grippe*), in croupous pneumonia, or in Asiatic cholera, in which diseases second attacks not infrequently occur. In localized infectious diseases, such as diphtheria, erysipelas, and gonorrhœa, one attack is not protective. Croupous pneumonia and Asiatic cholera should perhaps be grouped with diphtheria and erysipelas as local infections with constitutional symptoms resulting from the absorption of toxic products.

That immunity may result from a comparatively mild attack as well as from a severe one is a matter of common observation in the case of small-pox, scarlet fever, yellow fever, etc., and since the discovery of Jenner we have in vaccination a simple method of producing immunity in the first-mentioned disease. The acquired immunity resulting from vaccination is not, however, as complete or as permanent as that which results from an attack of the disease.

These general facts relating to acquired immunity from infectious diseases constituted the principal portion of our knowledge with reference to this important matter up to the time that Pasteur (1880) demonstrated that in the disease of fowls known as chicken cholera, which he had proved to be due to a specific micro-organism, a mild attack followed by immunity may be induced by inoculation with an "attenuated virus"—i. e., by inoculation with a culture of the pathogenic micro-organism the virulence of which had been so modified that it gave rise to a comparatively mild attack of the disease in question. Pasteur's original method of obtaining an attenuated virus consisted in exposing his cultures for a considerable time to the action of atmospheric oxygen. It has since been ascertained that the same result is obtained with greater certainty by exposing cultures for a given time to a temperature slightly below that which would destroy the vitality of the pathogenic micro-organism, and also by exposure to the action of certain chemical agents.

Pasteur at once comprehended the importance of his discovery, and inferred that what was true of one infectious germ disease was likely to be true of others. Subsequent researches by this *savant* and by other bacteriologists have justified this anticipation, and the demonstration has already been made for a considerable number of similar diseases—anthrax, symptomatic anthrax, rouget, etc.

In Pasteur's inoculations against anthrax, "attenuated" cultures are employed which contain the living pathogenic germ as well as the toxic products developed during its growth. Usually two inoculations are made with cultures of different degrees of attenuation—that is to say, with cultures in which the toxic products are formed in less amount than in virus of full power.

The most attenuated virus is first injected, and after some time the second vaccine, which if injected first might have caused a considerable mortality. The animal is thus protected from the pathogenic action of the most virulent cultures.

Now, it has been shown by recent experiments that a similar immunity may result from the injection into a susceptible animal of the toxic products contained in a virulent culture, independently of the living bacteria to which they owe their origin. The first satisfactory experimental evidence of this important fact was obtained by Salmon and Smith in 1886, who succeeded in making pigeons immune from the pathogenic effects of cultures of the bacillus of hog cholera by inoculating them with sterilized cultures of this bacillus. In 1888 Roux reported similar results obtained by injecting into susceptible animals sterilized cultures of the anthrax bacillus. Behring and Kitasato have quite recently reported their success in establishing immunity against virulent cultures of the bacillus of tetanus and the diphtheria bacillus by inoculating susceptible animals with filtered, germ-free cultures of these pathogenic bacteria.

In Pasteur's inoculations against hydrophobia, made subsequently to infection by the bite of a rabid animal, an attenuated virus is introduced subcutaneously in considerable quantity by daily injections, and immunity is established during the interval, the so-called period of incubation, which usually occurs between the date of infection and the development of the disease. That the immunity in this case also depends upon the introduction of a chemical substance present in the desiccated spinal cord of rabbits which have succumbed to rabies, which is used in these inoculations, is extremely probable. But, as the germ of rabies has not been isolated or cultivated artificially, this has not yet been demonstrated.

With these facts in view, let us proceed to consider briefly the various theories which have been offered in explanation of acquired immunity:

Exhaustion Theory.—For a time Pasteur supported the view that during an attack of an infectious disease the pathogenic micro-organism, in its multiplication in the body of a susceptible animal, exhausts the supply of some substance necessary for its development, that this substance is not subsequently reproduced, and that consequently the same pathogenic germ can not again multiply in the body of the protected animal.

In discussing this theory, in a paper published in the American Journal of the Medical Sciences (April, 1881), the writer says:

> Let us see where this hypothesis leads us. In the first place, we must have a material of small-pox, and a material of measles, and a material of scarlet fever, etc. Then we must admit that each of these different materials has been formed in the system and stored up for these emergencies—attacks of the diseases in question—for we can scarcely conceive that they were all packed away in the germ-cell of the mother and the sperm-cell of the father of each susceptible individual. If, then, these peculiar materials have been formed and stored up during the development of the individual, how are we to account for the fact that no new production takes place after an attack of any one of the diseases in question?
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> Again, how shall we account for the fact that the amount of material which would nourish the small-pox germ, to the extent of producing a case of confluent small-pox, may be exhausted by the action of the attenuated virus (germ) introduced by vaccination? Pasteur's comparison of a fowl protected by inoculation with the microbe of fowl cholera, with a culture fluid in which the growth of a particular organism has exhausted the pabulum necessary for the development of additional organisms of the same kind, does not seem to me to be a just one, as in the latter case we have a limited supply of nutriment, while in the former we have new supplies constantly provided of the material—food—from which the whole body, including the hypothetical substance essential to the development of the disease-germ, was built up prior to the attack. Besides this, we have a constant provision for the elimination of effete and useless products.
>
> This hypothesis, then, requires the formation in the human body, and the retention up to a certain time, of a variety of materials which, so far as we can see, serve no purpose except to nourish the germs of various specific diseases, and which, having served this purpose, are not again formed in the same system, subjected to similar external conditions, and supplied with the same kind of nutriment.

It is unnecessary to discuss this hypothesis any further, inasmuch as it is no longer sustained by Pasteur or his pupils, and is evidently untenable.

The Retention Theory, proposed by Chauveau (1880), is subject to similar objections. According to this view, certain products formed during the development of a pathogenic micro-organism in the body of a susceptible animal accumulate during the attack and are subsequently retained, and being prejudicial to the growth of the particular micro-organism which produced them, a second infection can not occur. Support for this theory has been found by its advocates in the fact that various processes of fermentation are arrested after a time by the formation of substances which restrain the development of the micro-organisms to which they are due. But in the case of a living animal the conditions are very different, and it is hard to conceive that adventitious products of this kind could be retained for years, when in the normal processes of nutrition and excretion the tissues and fluids of the body are constantly undergoing change. Certainly the substances which arrest ordinary processes of fermentation by their accumulation in the fermenting liquid, such as alcohol, lactic acid, phenol, etc., would not be so retained. But we can not speak so positively with reference to the toxic albuminous substances which recent researches have demonstrated to be present in cultures of some of the best-known pathogenic bacteria. It is difficult, however, to believe that an individual who has passed through attacks of half a dozen different infectious diseases, carries about with him a store of as many different chemical substances produced during these attacks, and sufficient in quantity to prevent the development of the several germs of these diseases. Nor does the experimental evidence relating to the action of germicidal and germ-restraining agents justify the view that a substance capable of preventing the development of one micro-organism should be without effect upon others of the same class; but if we accept the retention hypothesis, we must admit that the inhibiting substance produced by each particular pathogenic germ is effective only in restraining the development of the microbe which produced it in the first instance.

Moreover, if we suppose that the toxic substances which give pathogenic power to a particular micro-organism are retained in the body of an immune animal, we must admit that the animal has acquired a tolerance to the pathogenic action of these toxic substances, for their presence no longer gives rise to any morbid phenomena. And this being the case, we are not restricted to the explanation that immunity depends upon a restraining influence exercised upon the microbe when subsequently introduced.

Another explanation offers itself, viz., that *immunity depends upon an acquired tolerance to the toxic products of pathogenic bacteria.* This is a view which the writer has advocated in various published papers since 1881. In a paper contributed to the American Journal of the Medical Sciences in April, 1881, it is presented in the following language: "The view that I am endeavoring to elucidate is that, during a non-fatal attack of one of the specific diseases, the cellular elements implicated which do not succumb to the destructive influence of the poison acquire a tolerance to this poison which is transmissible to their progeny, and which is the reason of the exemption which the individual enjoys from future attacks of the same disease."

In my chapter on Bacteria in Infectious Diseases, in Bacteria, published in the spring of 1884, but placed in the hands of the publishers in 1883, I say: "It may be that the true explanation of the immunity afforded by a mild attack of an infectious germ disease is to be found in an acquired tolerance to the action of a chemical poison produced by the micro-organism, and consequent ability to bring the resources of Nature to bear to restrict invasion by the parasite." This theory of immunity has received considerable support from investigations made since that date, and especially from the experimental demonstration by Salmon, Roux, and others that, as suggested in the work from which I have quoted, immunity may result from the introduction into the body of a susceptible animal of the soluble products of bacterial growth—filtered cultures.

The theory of vital resistance to the toxic products evolved by pathogenic bacteria is also supported by numerous experiments which show that natural or acquired immunity may be overcome when these toxic products are introduced in excess, or when the vital resisting power of the animal has been reduced by various agencies. Thus Roger has shown that the rabbit, which has a natural immunity against symptomatic anthrax, succumbs to infection when inoculated with a culture of the bacillus of this disease, if at the same time it receives an injection of a sterilized or non-sterilized culture of *Bacillus prodigiosus*. Monti has succeeded in killing animals with old and attenuated cultures of the *Streptococcus pyogenes* or of *Staphylococcus pyogenes aureus*, by injecting at the same time a culture of *Proteus vulgaris*. A similar result may be obtained by subjecting animals to physical agencies which reduce the vital resisting power of the tissues. Thus, Nocard and Roux found by experiment that an attenuated culture of the anthrax bacillus, which was not fatal to guinea-pigs, killed these animals when injected into the muscles of the thigh after they had been bruised by mechanical violence. Charrin and Roger found that white rats, which are insusceptible to anthrax, became infected and frequently died if they were exhausted, previous to inoculation, by being compelled to turn a revolving wheel for a considerable time. Pasteur found by experiment that fowls, which have a natural immunity against anthrax, become infected and perish if they are subjected to artificial refrigeration after inoculation. This has been confirmed by the more recent experiments of Wagner (1890). According to Canalis and Morpurgo, pigeons which are enfeebled by inanition easily contract anthrax as a result of inoculation. Arloing states that sheep which have been freely bled contract anthrax more easily than others; and Serafini found that when dogs were freely bled, the bacillus of Friedländer, injected into the trachea or the pleural cavity, entered and apparently multiplied to some extent in the blood, whereas without such previous bleeding they were not to be found in the circulating fluid. Again, the simultaneous injection of certain chemical substances may overcome the vital resisting power of the tissues or fluids of the body in such a way that infection and death may occur as a result of inoculations into animals which have a natural or acquired immunity against the pathogenic micro-organisms introduced. Thus Arloing, Cornevin, and Thomas have shown that rabbits succumb to symptomatic anthrax when lactic acid is injected at the same time with the bacillus into the muscles. Nocard and Roux have obtained the same result by injecting various other substances, and their experiments show that the result is due to the injurious effects of the substance injected upon the tissues, and not to an increased virulence on the part of the pathogenic bacillus. The experiments of Leo are of a similar nature. By injecting phloridzin into rats he caused them to lose their natural immunity against anthrax. Certain anæsthetic agents have also been shown to produce a similar result. Platania communicated anthrax to immune animals—dogs, frogs, pigeons—by bringing them under the influence of curare, chloral, or alcohol; and Wagner obtained a similar result in his experiments on pigeons to which he had administered chloral.

In view of the results of recent experimental researches which show that, in certain cases at least, acquired immunity depends upon the formation of an antitoxine in the body of the immune animal, we are convinced that the theory of immunity under discussion, first proposed by the writer in 1881, can not be accepted as a sufficient explanation of the facts in general. At the same time we are inclined to attribute considerable importance to acquired tolerance to the toxic products of pathogenic bacteria as one of the factors by which recovery from an infectious disease is made possible, and subsequent immunity established. Of course, when we ascribe immunity to the "vital resistance" of the cellular elements of the body, we have not explained the *modus operandi* of this vital resistance or "reactive change," but have simply affirmed that the phenomenon in question depends upon some acquired property residing in the living cellular elements of the body. We have suggested that that which has been acquired is a tolerance to the action of the toxic products produced by pathogenic bacteria. But, as already stated, in the light of recent experiments, this theory now appears to us to be untenable as a general explanation of acquired immunity.

THE THEORY OF PHAGOCYTOSIS.—The fact that in certain infectious diseases due to bacteria the parasitic invaders, at the point of inoculation or in the general blood-current, are picked up by the leucocytes, and in properly stained preparations may be seen in their interior, has been known for some years. Now, the theory of phagocytosis assumes that the bacilli are picked up by the leucocytes and destroyed in their interior, and that immunity depends largely upon the power of these "phagocytes" to capture and destroy living pathogenic bacilli.

The writer suggested this as a hypothesis as long ago as 1881, in a paper read August 18, 1881, before the American Association for the Advancement of Science, in the following language: "It has occurred to me that possibly the white corpuscles may have the office of picking up and digesting bacterial organisms which by any means find their way into the blood. The propensity exhibited by the leucocytes for picking up inorganic granules is well known, and that they may be able not only to pick up but to assimilate, and so dispose of, the bacteria which come in their way, does not seem to me very improbable, in view of the fact that amœbæ, which resemble them so closely, feed upon bacteria and similar organisms."

At a later date (1884) Metschnikoff offered experimental evidence in favor of this view, and the explanation suggested in the above quotation is commonly spoken of as the *Metschnikoff theory.* The observations which first led Metschnikoff to adopt this view were made upon a species of daphnia which is subject to fatal infection by a torula resembling the yeast fungus. Entering with the food, this fungus penetrates the walls of the intestine and invades the tissues. In certain cases the infection does not prove fatal, owing, as Metschnikoff asserts, to the fact that the fungus cells are seized upon by the leucocytes, which appear to accumulate around the invading parasite (*chemiotaxis*) for this special purpose. If they are successful in overpowering and destroying the parasite, the animal recovers; if not, it succumbs to the general infection which results. In a similar manner, Metschnikoff supposes, pathogenic bacteria are destroyed when introduced into the body of an immune animal. The colorless blood-corpuscles, which he designates *phagocytes,* accumulate at the point of invasion and pick up the living bacteria, as they are known to pick up inorganic particles injected into the circulation. So far there can be no doubt that Metschnikoff is right. The presence of bacteria in the leucocytes in considerable numbers, both at the point of inoculation and in the general circulation, has been repeatedly demonstrated in animals inoculated with various pathogenic bacteria. The writer observed this in his experiments, made in 1881, in which rabbits were inoculated with cultures of his *Micrococcus Pasteuri;* and it was this observation which led him to suggest the theory which has since been so vigorously supported by Metschnikoff. But the presence of a certain number of bacteria within the leucocytes does not prove the destructive power of these cells for living pathogenic organisms. As urged by Weigert, Baumgarten, and others, it may be that the bacteria were already dead when they were picked up, having been destroyed by some agency outside of the blood-cells. As heretofore stated, we have now experimental evidence that blood-serum, quite independently of the cellular elements contained in it in the circulation, has decided germicidal power for certain pathogenic bacteria, and that the blood-serum of the rat and other animals which have a natural immunity against anthrax is especially fatal to the anthrax bacillus.

Numerous experiments have been made during the past two or three years with a view to determining whether pathogenic bacteria are, in fact, destroyed within the leucocytes after being picked up, and different experimenters have arrived at different conclusions. But in certain infectious diseases, and especially in anthrax, the bacilli included within the leucocytes often give evidence of degenerative changes, which would support the view that they are destroyed by the leucocytes, unless these changes occurred before they were picked up, as is maintained by Nuttall and others.

Metschnikoff concludes an address delivered at the Pasteur Institute in Paris, in December, 1890, as follows: "It is not possible at the present time to state fully and accurately all these influences which are associated in aiding phagocytic action; but already we have the right to maintain that, *in the property of its amœboid cells to include and to destroy micro-organisms, the animal body possesses a formidable means of resistance and defense against these infectious agents.*" This statement, we think, is justified by the experimental evidence relating to phagocytosis. But in view of experimental evidence, to be referred to later we can not accept the so-called Metschnikoff theory as a sufficient explanation for the facts relating to acquired immunity in general, and must regard phagocytosis simply as a factor which, in certain infectious diseases, appears to play an important part in enabling immune animals to resist invasion by pathogenic bacteria.

Going back to the demonstrated fact that susceptible animals may be made immune by inoculating them with the toxic products produced during the growth of certain pathogenic bacteria, we may suppose either that immunity results from the continued presence of these toxic products in the body of the inoculated animal, or to a tolerance acquired at the time of the inoculation and subsequently retained, by transmission from cell to cell, as heretofore suggested. Under the first hypothesis—retention theory—immunity may be explained as due to a continued tolerance on the part of the cellular elements of the body to the toxic substances introduced and retained, or to the effect of these retained toxic products in destroying the pathogenic bacteria, or in neutralizing their products when these are subsequently introduced into the body of the immune animal. We can not understand how toxic substances introduced in the first instance can neutralize substances of the same kind introduced at a later date. There is something in the blood of the rat which, according to Behring, neutralizes the toxic substances present in a filtered culture of the tetanus bacillus; but whatever this substance may be, it is evidently different from the toxic substance which it destroys, and there is nothing in chemistry to justify the supposition last made. Is it, then, by destroying the pathogenic micro-organism, that these inoculated and retained toxic products preserve the animal from future infection? Opposed to this supposition is the fact that the blood of an animal made immune in this way, when removed from the body does not prove to have increased germicidal power as compared with that of a susceptible animal of the same species. Again, these same toxic substances in cultures of the anthrax bacillus, the tetanus bacillus, the diphtheria bacillus, etc., do not destroy the pathogenic germ after weeks or months of exposure. And, when we inoculate a susceptible animal with a virulent culture of one of these micro-organisms, the toxic substances present do not prevent the rapid development of the bacillus; indeed, instead of proving a germicide they favor its development, which is more abundant and rapid than when attenuated cultures containing less of the toxic material are used for the inoculation. In view of these facts it is evident that acquired immunity does not result from the direct action of the products of bacterial growth, introduced and retained in the body of the immune animal, upon the pathogenic micro-organism when subsequently introduced, or upon its toxic products.

But there is another explanation which, although it may appear *a priori* to be quite improbable, has the support of recent experimental evidence. This is the supposition that *some substance is formed in the body of the immune animal which neutralizes the toxic products of the pathogenic micro-organism.* How the presence of these toxic products in the first instance brings about the formation of an "antitoxine" by which they are neutralized is still a mystery; but that such a substance is formed appears to be proved by the recent experiments of Ogata, Behring and Kitasato, Tizzoni and Cattani, G. and F. Klemperer, and others, including my own.

Ogata and Jasuhara, in a series of experiments made in the Hygienic Institute at Tokio (1890), discovered the important fact that the blood of an animal immune against anthrax contains some substance which neutralizes the toxic products of the anthrax bacillus. When cultures were made in the blood of dogs, frogs, or of white rats, which animals have a natural immunity against anthrax, they were found not to kill mice inoculated with them. Further experiments showed that mice inoculated with virulent anthrax cultures did not succumb to anthrax septicæmia if they received at the same time a subcutaneous injection of a small quantity of the blood of an immune animal. So small a dose as one drop of frog's blood, or one half drop of dog's blood, proved to be sufficient to protect a mouse from the fatal effect of an anthrax inoculation. And the protective inoculation was effective when made as long as seventy-two hours before, or five hours after, infection with an anthrax culture. Further, it was found that mice which had survived anthrax infection as a result of this treatment were immune at a later date (after several weeks) when inoculated with a virulent culture of the anthrax bacillus. Behring and Kitasato have obtained similar results in their experiments upon tetanus and diphtheria, and have shown that the blood of an immune animal, added to virulent cultures before inoculation into susceptible animals, neutralizes the pathogenic power of these cultures. Tizzoni and Cattani ascribe the protection of animals which have acquired an immunity against tetanus to the presence of an albuminous substance which they call the tetanus antitoxine. This they have isolated from the blood of immune animals; and have shown by experiment that it neutralizes the potent toxalbumin of tetanus in test-tube cultures as well as in the bodies of infected animals. G. and F. Klemperer have recently (1891) published an important memoir in which they give an account of their researches relating to the question of immunity, etc., in animals subject to the form of septicæmia produced by the *Micrococcus pneumoniæ crouposæ*. They were able to produce immunity in susceptible animals by introducing into their bodies filtered cultures of this micrococcus, and proved by experiment that this immunity had a duration of at least six months. They arrive at the conclusion that the immunity induced by injecting filtered cultures is not directly due to the toxic substances present in these cultures, but that they cause the production in the tissues of an antitoxine which has the power of neutralizing their pathogenic action. Emmerich, in a communication made at the recent (1891) International Congress for Hygiene and Demography, in London, reports results which correspond with those of G. and F. Klemperer so far as the production of immunity is concerned, and also gives an account of experiments made by Dönissen in which the injection of twenty to twenty-five cubic centimetres of blood or expressed tissue juices, filtered through porcelain, from an immune rabbit into an unprotected rabbit, subsequently to infection with a bouillon culture of "*Diplococcus pneumoniæ*," prevented the development of fatal septicæmia. Even when the injection was made twelve to fifteen hours after infection, by inhalation, the animal recovered. Emmerich and Mastraum had previously reported similar results in experiments made upon mice with the *Bacillus erysipelatos suis* (rothlauf bacillus). White mice are very susceptible to the pathogenic action of this bacillus. But mice which, subsequently to infection, received by injection the expressed and filtered tissue juices of an immune rabbit, recovered, while the control animals succumbed. According to Emmerich, the result in these experiments was due to a destruction of the pathogenic bacilli in the bodies of the injected animals; and the statement is made that at the end of eight hours after the injection of the expressed tissue juices all bacilli in the body of the infected animal were dead. The same liquid did not, however, kill the bacilli when added to cultures external to the body of an animal. The inference, therefore, seems justified that the result depends, not upon a substance present in the expressed juices of an immune animal, but upon a substance formed in the body of the animal into which these juices are injected. We have, however, an example of induced immunity in which the result appears to depend directly upon the destruction of the pathogenic micro-organism in the body of the immune animal. In guinea-pigs, which have an acquired immunity against *Vibrio Metschnikovi*, the blood-serum has been proved to possess decided germicidal power for this "vibrio," whereas it multiplies readily in the blood-serum of non-immune guinea-pigs. (Behring and Nissen.)

The antitoxines thus far referred to are from animals which have an acquired immunity against virulent cultures of well-known pathogenic bacteria. But we have also experimental evidence showing the presence of antitoxines in animals immune against rabies and against vaccinia, two infectious diseases in which the specific infectious agent has not been demonstrated. Prof. Tizzoni, and his associate, Dr. Schwarz, have recently (1892) published the results of their experiments relating to the presence of an antitoxine in the blood of rabbits which have an acquired immunity against rabies. And I have shown by experiments made during the past two months that the blood of vaccinated and consequently immune calves contains an antitoxine which neutralizes the specific virulence of vaccine virus, both human and bovine; also that blood-serum from a person who has recently suffered an attack of small-pox neutralizes vaccine virus after contact for two or three hours.

The account which I have given of the experimental evidence relating to the presence of antitoxines, or, as they are called by Hankin, "defensive proteids," in the body of immune animals has been largely taken from a paper which I read at the recent meeting (May, 1892) of the Association of American Physicians, entitled Practical Results of Bacteriological Researches. Time will not permit me on the present occasion to consider the question of therapeutic possibilities in the use of antitoxines, but I may mention that already we have reports of six cases of traumatic tetanus successfully treated with the tetanus antitoxine obtained by Prof. Tizzoni from the blood of immune dogs. I confess I have sanguine hopes that other infectious diseases may prove to be amenable to a similar specific treatment. But, whatever may be the practical results following the discovery of these "defensive proteids" in the bodies of immune animals, it must be admitted that this addition to our knowledge is an important event in the history of scientific medicine. For this reason, and because the experimental evidence is of such recent date that the facts are not generally known, I have made this the principal topic of my address. It is scarcely necessary to add that the experimental evidence detailed gives strong support to the view that acquired immunity depends upon the formation of antitoxines in the bodies of immune animals. It is also probable that recovery from an infectious disease depends upon the formation of an antitoxine during the attack, by which the toxic substances giving rise to the morbid phenomena characterizing each specific disease are neutralized in the body of the infected individual.

A recent notice in the Monthly of a book on Right-handedness has called forth from Mr. George Wilson, President of the Lafayette County Bank, Lexington. Mo., the story of the "office cat of the bank, Ephraim, who is decidedly and persistently right-handed." "He sometimes," says Mr. Wilson, "laps milk like other cats, and sometimes sits close up to the pan and dips his paw in the milk and carrying it to his mouth, licks the drop of milk off. Noticing that he always used his right paw, I tried to get him to use the left one, first by setting the pan of milk on his left side and afterward by dipping his left foot in the milk, so as to get him started in the use of the left. He would shake the milk off his left paw and go on eating with the right one, and we have never by any expedient been able to get him to eat with the left paw."

A Polynesian Society has been formed in Wellington, New Zealand, the chief object of which is to secure as far as possible a systematic study of the ethnology and philology of the island groups collectively designated as Polynesia.

FURTHER STUDY OF INVOLUNTARY MOVEMENTS.*

By JOSEPH JASTROW, Ph. D.,

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IN a former article (Popular Science Monthly, April, 1892) various illustrations were given of the involuntary movements of the hand toward the object or locality to which the subject was giving his attention: whether he were counting the strokes of a metronome or the oscillations of a pendulum, reading colors or words, thinking of a building, locality, or hidden object, a very fair though variable index of the direction of his thoughts could be derived from the involuntary movements of the hand. The record was obtained by means of an apparatus called the automatograph, the essential parts of which were a pair of glass plates, suitably mounted, and between them three well-turned brass balls; the hand rests upon the upper plate, which, upon the slightest impulse, rolls upon the balls, and the movement thus imparted to the plate is recorded. The recording device may be used separately, and is shown in full size in Fig. 1. There is a cork C, pierced by a glass tube T, within which a pointed glass rod R moves freely up and down; a rubber band B is useful in raising the pencil from the record as well as in preventing the rod from falling through the tube. The record is made upon a piece of glazed paper stretched over the glass of a ground-glass drawing-frame, such as children use for tracing outlines; the paper is blackened with lamp-soot, and the record may be made permanent by bathing it in shellac and alcohol. This recording device, without anything else, will record involuntary movements: the cork is held in the extended hand with the rod over the record-plate, which is placed upon a table; or, again, the record-plate may be held in the hand and the recording device held firmly over

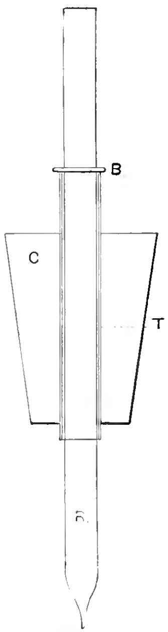

Fig. 1.—Device for recording Movements. The glass rod, R, moves freely up and down in the glass tube, T, held in the cork, C. The rubber band, B, prevents the rod from falling through the tube.

* The results of this paper were obtained with the co-operation of Thomas P. Carter and Edward P. Sherry, of the class of 1892, University of Wisconsin.

it.* In either way we have an extremely simple means of obtaining records of involuntary movements, which any one interested

Fig. 2.—Counting Metronome. ⇻ Upper line, movements of head; lower line, of hand on automatograph; time, 45 seconds. The head movements are reversed, but have been again reversed for readier comparison. Figs. 2 to 11 are all obtained upon the same subject. The arrows indicate the direction in which the object attended to was situated.

may construct and test for himself. The use of such a device is not confined to the hand; the plate or the rod may be fixed to other portions of the body.

Having shown that the hand moves toward the direction of one's thoughts, the next important step is to determine whether this movement is altogether the expression of the subject's mental activity, and, if not, what other factors

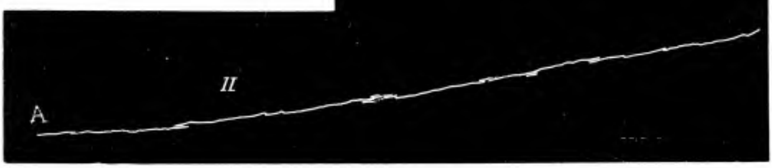

Fig. 3.—Counting Metronome. Facing ⇻. Automatograph, sitting. I, ⇺; time, 105 seconds. II, ⇻; time, 45 seconds.

contribute to it; and, further, in what part or parts of the body it originates, what are its components, and the like. These movements have a close connection with the body as well as with the

* It is to be noted that in this case the record will be in a direction the opposite of the real movement.

mind, and it is essential to determine in what measure each appears in the general result.

If you hold out your arm nearly on a level with the shoulders and in line with them, you perceive at once that movements of the hand to the front are much more readily made than to the rear, and movements toward the body more readily than those away from the body; the tendency of the hand is to move along a circle of which the shoulder is the center. What we require is a position in which movements in any direction are as readily made as in any other; and this may be approximated, though only approximated, by holding the hand at an angle of about 45° with the line joining the shoulders, and with the elbow bent at an angle of about 120°; this position * is

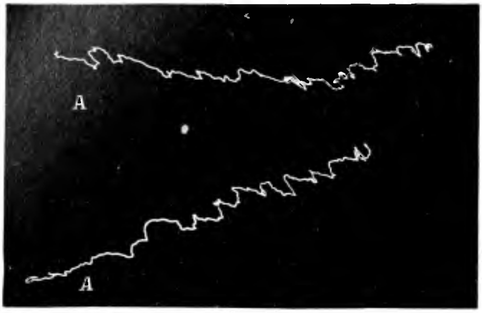

Fig. 4.— ⇸ Counting Metronome. Right hand holds pencil, left hand holds record; time of each, 90 seconds. Facing ⇸. Upper line, standing; lower line, sitting.

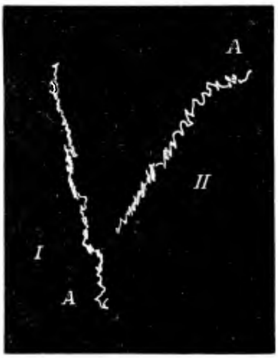

Fig. 5.—Thinking of a Building. Facing ↕; standing. Right hand holds pencil, left hand holds record; time of each, 60 seconds. I, ↕; II, ↕; shows respiration.

Fig. 6.—Counting Metronome. Right hand holds pencil, left hand holds record. From A to B, ↕; from B to C, ⇸; from C to D, ↕; from D to E, ⇷; standing; each part, 45 seconds.

recommended for the normal tests. The usual result is a movement toward the object of attention; but when that is to the rear, this tendency is sometimes outweighed by the natural tendency

* In one series we were able to measure the extent of movements in various directions, and found half again as much movement toward the front as toward the rear, and a third again as much toward as away from the body.

for the arm to move forward, and the result is then a smaller and less direct movement forward than when the object of attention is to the front. An instance of this, obtained under other but comparable circumstances, appears in Fig. 3, while Figs. 5 and 6 illustrate the more usual result. We conclude, then, that the position of the body is an important factor, but does not detract from the accepted psychological interpretation of these movements. While observing the subject we may note movements of the body as a whole, and of the arm or hand; the movement of the body is an irregular swaying with the feet as the point of attachment, and this we recorded by fixing the recording plate upon the subject's head, and suspending the pencil above it. It was found that the head like the hand moved toward the object of at-

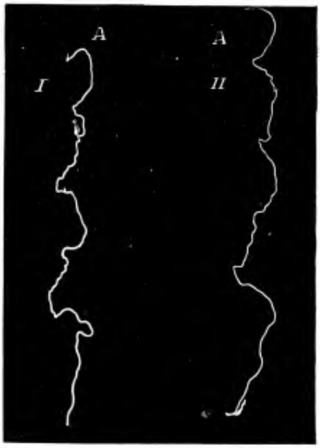

FIG. 7.—↕ THINKING OF A BUILDING. Standing ↕. I, left hand; II, right hand; both holding record near the body; time, 35 seconds; records reversed.

FIG. 8.—↕ THINKING OF A BUILDING. Facing ↕. I, left hand held extended far out; II, right hand held close to body; each hand holds record; time, 35 seconds; records reversed.

tention; and, further, that it moved as readily toward the object when the latter was to the front, to the rear, or to either side. To determine how far this swaying is the same in head and hand, we record both at the same time. Fig. 2 illustrates the correspondence of the two movements. From a number of such tests we conclude that the swaying of the body contributes an important factor to the automatograph records, and that the movements of the head are apt to be more extensive than those of the hand.

To eliminate this swaying of the body, we may experiment with the subject seated; we then obtain a distinctive record II (of Fig. 3), in which the oscillations have almost disappeared, and in which the tendency to move along a circle is marked. A still better method of eliminating this swaying is to hold the recording plate in one hand and the pencil in the other; in this way the pencil and the plate sway alike, and no record of it is made. The very fine movements thus obtained are shown in Fig. 4; this figure also shows the slight difference between a record taken by this method while the subject is sitting and while standing, which further proves that the swaying of the body has been eliminated. Traces of periodic oscillations are noted in Fig. 4; these are due to respiration movements, and in II, of Fig. 5, they are unusually distinct and regular, about twenty to the minute. The forearm of the hand holding the record-plate rests against the body while the recording hand is held free from it, and thus the abdominal movements are recorded. The movements toward the object of attention appear throughout. Fig. 5 figures a movement toward the rear as well as toward the front; while Fig. 6 presents a most beautifully regular movement in all four directions. As the metronome, the strokes of which the subject is counting, is carried from one corner of the room to the next, the hand involuntarily follows it and records an almost perfect square.

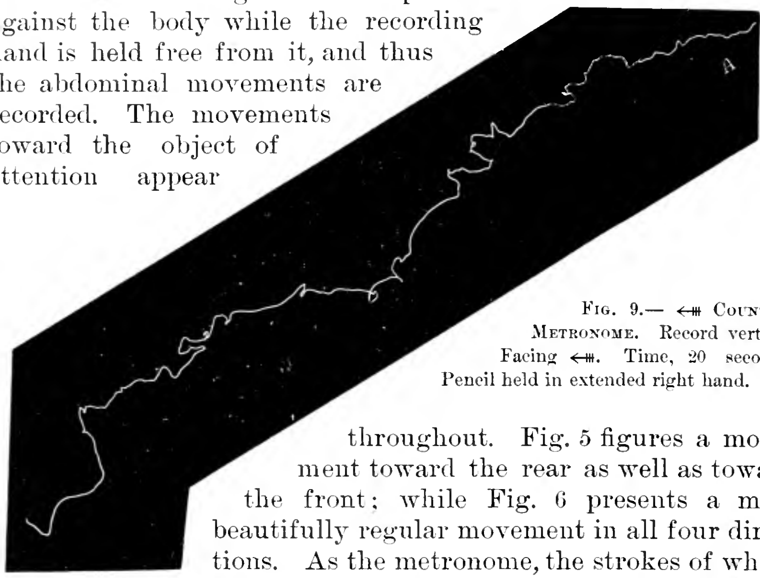

Fig. 9.— ⟵⫲ Counting Metronome. Record vertical. Facing ⟵⫲. Time, 20 seconds. Pencil held in extended right hand.

It is further interesting to record the movements of the two hands during the same experiment; a correspondence of movement would be attributed to a common swaying of the body, but this would not exclude symmetrical movements of the hands as well. Fig. 7 illustrates the close similarity of the movements; while Fig. 8 shows the importance of the position of the arms in such an experiment. The hand that is held away from the body moves more extensively; the form of the movement remains similar. All the above records (and Figs. 9, 10, and 14) were obtained upon the same subject; they are therefore comparable with one another, and illustrate the analysis of the resulting movements into their several factors.

Involuntary movements are not limited to the horizontal plane; we may record vertical movements by holding the recording device in a slanting position, and fixing the record-plate upon the wall. The main characteristic of such a record is the sinking of the arm from fatigue; the movement is rapid and coarse (I of Fig. 10). If the attention be directed to the front, we obtain a resultant of the two tendencies, as is shown in the diagonal line of Fig. 9. Fig. 10 illustrates an interesting point similar to that illustrated in Fig. 3. When the attention is directed downward, the hand falls rapidly, I; but when the attention is directed upward, very little movement at all takes place—the tendency to move toward the object of attention constantly counteracting the tendency for the arm to fall.

Fig. 10.—I, ↧ Record-plate Vertical. Thinking of one's feet. Time, 45 seconds. II, ↥ thinking of a point overhead. Time, 45 seconds.

While we have not been altogether successful in recording by these involuntary movements the various powers of different sense-impressions to hold the attention, the few successful results are especially interesting. In Fig. 11 the outline I is the movement of the hand during the thirty-five seconds that the subject was counting the strokes of a metronome; the outline II is the movement while counting for twenty-five seconds the oscillations of a pendulum. The latter movement is much more extensive than the former; the visual holds the attention better than the auditory impression. The subject of this record is a noted American novelist, and his description of his own mental processes entirely corresponds with this result. He is a good visualizer, and is eye-minded in every respect.

We turn to Fig. 12. The subject was asked to call the names of a series of small patches of colored papers hanging upon the wall in front of him. He did this with some uncertainty for thirty-five seconds, and during this time his hand on the automatograph moved from A to A′. At the latter point he was asked to count the oscillations of a pendulum; this entirely changed the movement, the hand at once moving rapidly toward the pendulum. The pendulum was a more attractive sense-impression than the colors; the special point of interest in this record is, that upon

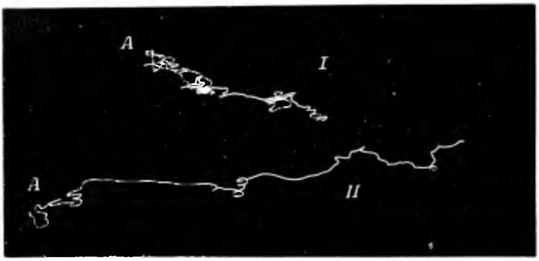

Fig. 11.—⇻ I, Counting Metronome. Automatograph. Facing ⇻. Time, 35 seconds. ⇻ II, Counting Pendulum. Automatograph. Facing ⇻. Time, 25 seconds.

examination the subject's color-vision proved to be defective and thus explained the failure of the colors to hold his attention.

An important problem relates to the possible correlation of types of involuntary movements with age, sex, temperament, disease and the like. A few observations upon children are interesting in this regard. They reveal the limited control that children have over their muscles, and how difficult it is for them to fix the attention when and where desired. The movements they make are large, with great fluctuations, and irregularly toward the object of attention. Fig. 13 illustrates some of these points; in thirty-five seconds the child's hand moved by large steps seven

Fig. 12.—⇻ Facing ⇻. Hand on Automatograph. From A to A′, reading colors, 35 seconds. From A′ on, counting pendulum, 25 seconds.

inches toward the pendulum, and the entire appearance of the outline is different from those obtained upon adults.

Much attention has recently been paid to automatic writing, or the unconscious indication of the nature, not the direction, of one's thoughts while the attention is elsewhere engaged. We attempted this upon the automatograph by asking the subject to view or think of some letter or geometric figure, and then searching the record for some trace of the outline of the letter or figure; but always with a negative result. While unsuccessful in this

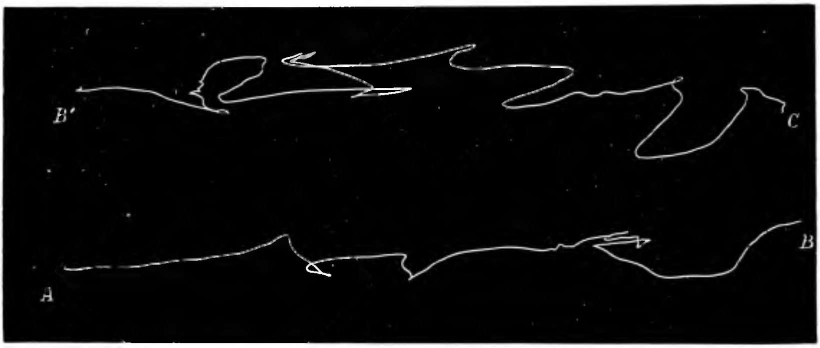

FIG. 13.— ⇸ HAND ON AUTOMATOGRAPH. Facing ⇸. Counting pendulum. Time, 35 seconds. The record from B' to C is continuous with that of A to B. The subject a child of eleven years.

sense, the records prove of value in furnishing a valuable contrast to the experiments in which the attention was fixed in a definite direction. For example, the subject is thinking of the letter O; he does not think of it as in any special place, and the record, Fig. 14, likewise reveals no movement in any one direction. Two

FIG. 14.—THINKING OF LETTER O. Pencil in hand; record on table. I, standing; II, sitting.

records are shown quite similar in significance, and illustrating as well the difference between the movements while standing and while sitting.

We have thus illustrated a variety of involuntary movements obtained in different ways and with bearings upon many points of importance to the psychologist. They by no means exhaust the possibilities of research, or the deduction of conclusions in this field of study, but simply illustrate in an imperfect way how abundant and intricate are the expressions of the thoughts that lie within.

THE WAGE-CONTRACT AND PERSONAL LIBERTY.*

By CONRAD RENO.

IN this reply to that part of Mr. Atkinson's interesting article which affirms that any State regulation of wages or of the hours of work is necessarily an abridgment of personal liberty, and therefore vicious and unjustifiable, the writer intends to confine his attention to two propositions: (1) That the settlement of labor disputes by the State does not necessarily involve an abridgment of personal liberty; (2) that compulsory arbitration through a State tribunal is the remedy for labor disputes, strikes, and lockouts.

The virtues of the "age of contract" are extolled by all disciples of the individualist school of thought, from Mr. Herbert Spencer to Mr. Edward Atkinson. Its superiority over the "age of status"—i. e., the age of slavery—no one will deny. Its adoption marks an upward step in the march of progress and civilization. As a means of attaining justice the contract has many advantages over the sword or brute force, by which human slavery was established and maintained. The right of contract is not, however, an end in itself (as this school seems to think), but merely a means to an end; and that end is justice. In the administration of justice experience has proved it to be necessary to impose many restrictions upon the right of free contract. Judge Ray has recently published a large legal work upon the subject of Contractual Limitations, and most persons will be surprised at the great number of restrictions that the law places upon this right. A full list of such cases would be tiresome, and only the more important ones will be mentioned. From time immemorial it has been customary for the State to fix a maximum rate of interest for the use of money, a maximum charge for the use of ferries, hacks, etc., for the services of millers in grinding corn, and a maximum charge of innkeepers and wharfingers for the use of their premises. In recent years the State has also fixed a maximum charge for the use of railroads and grain elevators. The constitutionality of State statutes fixing grain-elevator charges has been twice affirmed by the Supreme Court of the United States within twenty years, and the highest courts of the great States of New York and Illinois have also reached the same conclusion.† In the extensive class of insurance contracts the State

* A reply to Mr. Edward Atkinson's paper on Personal Liberty, in The Popular Science Monthly for February, 1892.

† Munn *vs.* Illinois, 94 U. S., 113; Budd *vs.* New York, 143 U. S., 517; People *vs.* Budd, 117 N. Y., 1; Munn *vs.* People, 69 Ill., 80

does not hesitate to prescribe their terms and conditions and to prevent forfeitures by contract; and the constitutionality of such State statutes interfering with the freedom of contract has been upheld by the Supreme Court of the United States and by the highest State courts of Ohio and Wisconsin.* Besides these, there is a numerous class of contracts which the State declares shall not be made at all, or if made shall be void in law, because contrary to public policy, such as contracts in restraint of trade, gambling contracts, and contracts between husband and wife. Does Mr. Atkinson consider these State acts infringements of personal liberty or unjustifiable interferences with the freedom of contract? If so, he constitutes one of a small minority.

Turning now to the wage-contract, the question arises, "Is the State justified in fixing a minimum wage and a maximum time for work?" It is perhaps needless to say that the term "State" is here used to mean the people or the public acting through an agency or tribunal created by the people and in furtherance of their will. It does not mean something extrinsic and superior to the people's will, such as the monarchy of France was at the time when Louis XIV exclaimed, "I am the state!" In this country, if the State ever undertakes to regulate these matters, it will be done in pursuance of the will of the majority, and not of any one man or a minority. The businesses in which labor wishes the assistance of the State in the direction of restricting the freedom of contract are conducted almost exclusively by corporations under charters granted by the State. The three principal ones are railroading, manufacturing, and mining, and only an insignificant fraction of any one of these businesses is conducted by private individuals or partnerships. Although it may be of theoretic value, it is therefore of very little practical value to inquire into the right of the State to regulate the wage-contract between individuals. Now, the individual employer or partnership stands upon firmer ground in this respect than does the corporate employer. The State is justified in interfering with the latter more than with the former, for the reason that the corporation has received certain privileges and immunities from the State which the other employer has not received. In the first place, the corporation derives its being or existence from the State, and also its right to transact business. In the next place, the corporate form enables the capital of many individuals to be combined and used for one common purpose. But the most important immunity is that of limited liability, whereby the members of the corporation escape the uni-

* Equitable Life Insurance Company *vs.* Clements, 140 U. S., 226; Insurance Company *vs.* Leslie, 47 Ohio St., 409; Queen Insurance Company *vs.* Leslie, 24 N. E. Rep. (Ohio), 1072; Reilly *vs.* Franklin Insurance Company, 43 Wis., 449.

versal liability of individuals or partners, and only risk the portion of their wealth which they invest in the corporation. This feature of limited liability, probably more than any other, accounts for the growth and number of corporations. Private individuals or copartnerships do not enjoy this privilege or immunity, but remain liable to loss to the full extent of their possessions. It is clear, therefore, that the moral right of the State or society as a whole to regulate wage-contracts with a corporation is greater than with individuals or firms, provided the necessity exists and the wage-earners desire it. It is not intended to confine the discussion to the case of corporate employers, but merely to point out some differences between the two classes of employers.

Mr. Spencer's opinion that the State has no moral right to interfere with the freedom of contract between employer and employed, or to regulate wages in any way, is based upon the analogy supposed to exist between human labor and commodities. Because, in his opinion, the State has no right to regulate the price of bread, or the rate of interest, or the price of other commodities, therefore it has not the moral right to regulate the price of human labor, with the exception of labor for life, or slavery. Is this analogy correct? Is human labor a commodity? No; human labor is the creator of commodities, and commodities are things created by human labor. The creator is always superior to the thing created. The shoemaker is superior to the shoe; the watchmaker to the watch; and God to man. The slaveholder also believed that human labor when clothed in black was a commodity, and that negroes could be bought and sold as chattels; and it took four years of civil war to establish the contrary. Labor is much more than a commodity; it is the bone and sinew of the State, the very essence of its existence. It is the sole means of support of millions of human beings—men, women, and children. Those who have only their labor to sell are more entitled to the protection of the State than those who have commodities to sell.

Mr. Spencer's admission that the State has the right to forbid the sale of one's self into slavery, or the sale of one's services for life, as well as to hinder freedom of contract when it endangers national existence, also proves his analogy to be unsound. For, if the State may regulate or forbid the sale of one's services for life, it may also regulate the sale of one's services for ten years, or five years, or one year, or a shorter term; and, if the State may hinder the freedom of contract when national existence is thereby endangered, why may it not hinder the freedom of contract when the existence of a large body of its citizens is thereby endangered? Their existence is endangered when they can not, by means of their utmost exertions, earn sufficient wages to purchase the necessaries of life.

That the great mass of wage-earners favor State regulation of some sort will probably be conceded. Scarcely a month passes that Congress and the State Legislatures are not asked by labor interests to restrict the freedom of contract in one way or another. They believe that their wages may be increased by legislation, just as the price of commodities is increased by tariff laws. If legislation can lower the rate of wages below the contract rate, it is difficult to see why it can not also raise the rate of wages above the contract rate. For centuries the employing class of England legislated in its own interest and kept the rate of wages below the contract rate. This they did, first, by various Statutes of Laborers, passed by Parliament, giving the employing class power to fix wages, and punishing laborers who asked or received higher wages; secondly, by laws abolishing trade guilds and confiscating their property; thirdly, by acts of Parliament and decisions of the courts holding that peaceful combinations among workmen to raise wages were conspiracies and punishable by fine or imprisonment; and, fourthly, by acts of Parliament debasing the currency, by which the purchasing power of the laborer's shilling or penny was greatly lessened. Prof. Rogers, in his great work entitled Six Centuries of Work and Wages, shows how by these various legislative means the English laborer's condition was reduced from that of comparative comfort in the fourteenth century to that of semi-starvation in the eighteenth. This system was inaugurated in 1350, shortly after the Great Plague, which destroyed one third of the entire population of England. At that time the employing class, which, of course, controlled legislation, seems to have had some excuse for passing the Statute of Laborers. The supply of labor being thus suddenly reduced one third, the demand was intense, and the laborers could get exorbitant prices for their work. The contract rate depending upon supply and demand was abnormally and unreasonably high,* and therefore the employing class brought all the machinery of the State to bear upon the situation, and finally succeeded in reducing the rate below the contract rate. This policy was pursued by England into the dawn of the nineteenth century, when, the conditions having changed and there being an over-supply of labor and the contract rate correspondingly low, the Statutes of Laborers were magnanimously repealed.

During all this time of State regulation of wages in favor of the employing class we look in vain for any philosopher to arise

* The preamble to the statute recites that wages had risen to double or treble the rate that prevailed immediately before the plague.

and proclaim that the sacred right of freedom of contract or of personal liberty was thereby impaired. But, as soon as there is a chance of the wage-earners being able to control legislation and they indicate their desire to increase wages, it is immediately discovered by many would-be teachers and philosophers of the individualist school that this sacred right is imperiled, and that it would be sacrilegious to touch it with the vulgar hand of the State. This school overlooks the actual condition of affairs and bases its conclusions on an ideal state of facts which does not exist except in the imagination of its members. If employer and employed stood upon an equal footing; if the necessities of one were equal to the necessities of the other; if the abilities of both were equal—then freedom of contract would produce not only good but also just results. But no one with any knowledge of the world can affirm that these conditions exist. The condition of labor more nearly corresponds to that of a man who falls into a well, far removed from human habitation. After he has been there for a day without food and sees starvation staring him in the face, he attracts the attention of a stray passer-by by his cries for help. The latter comes up, but refuses to lower his rope and pull him out unless he receives five hundred dollars. The next day another man says he will help him out for one thousand dollars, but this offer is also declined. The third day, being nearly starved, he contracts to pay a third man fifteen hundred dollars for assisting him out of the well, and so regains his freedom. Labor has fallen into the well of poverty, and Capital stands on the brink and says in effect: "I did not put you there, and therefore I am justified in making the best bargain I can with you. In fact, I am forced to do so by the competition of some of my rivals who sell the same commodities. They screw wages down to the lowest point, and I can't compete with them unless I do likewise. I must either pay the same low wages, or retire from business, or become bankrupt."

It is precisely at this point that the pinch comes, which exerts a controlling influence upon the average employer. He cares nothing for fine-spun theories respecting the freedom of contract or personal liberty, but he knows from every-day experience that he can not pay high wages so long as there are even a few unscrupulous and avaricious employers in the same line of business who succeed in obtaining labor at low rates. He is forced to compete with them in the sale of his commodities, and the price of labor is a large item in the cost of their manufacture. Higher wages would eat up his profits, and drive him out of business or into bankruptcy. "If," he says, "some plan can be invented by which all my competitors will be obliged to pay high wages, then I have no objection to paying the same wages, for then we shall

all stand upon an equality with respect to the cost of labor. This will increase the cost of production; but, as the increase applies alike to all my rivals as well as to myself, I can make myself whole by raising the price of the finished product, as they will do the same."

The doctrine of the freedom of contract will never place the honest and generous employer upon an equal footing with the dishonest and avaricious employer in the cost of labor. Under it the latter will always obtain an advantage over the former. This doctrine, therefore, puts a premium upon the possession of these undesirable qualities. Moreover, under the law of competition in commodities, the honest and generous employer is forced to conform substantially to the rate of wages set by the dishonest and avaricious. This tendency is inherent in the wage system, and must increase, unless some remedy be found; for evil and grasping men can not be kept out of the ranks of employers, and only a few of them are required to depress wages below their fair value. This operates not only to the detriment of their employés, but also to the detriment of all other employés. Is it right that a few evil characters should commit this injustice upon labor, and control the vast majority of both classes? Should the State, or society in its organized form, permit them to do this wrong? It is submitted that it should not, and that some State agency should be devised to prevent or to remedy it.

About a year ago the writer published a pamphlet entitled State Regulation of Wages, in which he outlined a plan to remedy this difficulty. Its essential feature was the establishment of State Boards of Labor or Arbitration for the settlement of disputes between employers and employed, with power to fix the minimum wage and the maximum hours of work, upon the request of a certain proportion or number of either side. In determining the minimum wage, the board should not be controlled by the rate of wages now prevailing under the "iron law of wages" of supply and demand, but by what may be called the *golden rule of wages,* by which labor is entitled to receive a fair and just proportion of the wealth which it creates, irrespective of supply and demand. The minimum annual wage should be that required to support the average workman and his family in frugal comfort. The adoption of this plan would place all employers upon an equality in the cost of labor and relieve the generous employer from the competition of the avaricious one upon this large item in the cost of production. It is true that its adoption by a single State would not protect the employers of that State from the competition of their rivals in other States or foreign countries; but if the plan were found to work well in one State it would be speedily followed in other States; and, as to foreign competition, the tariff laws, if not already sufficiently high to cover the difference in the cost of labor, could easily be made so.

If the people of a State see fit to establish such a Board of Labor or Arbitration for the settlement of labor disputes, it is no more an infringement of their personal liberty than is the establishment of courts of law for the settlement of legal disputes. In both cases the restraint is self-imposed, and may be thrown off at will by disestablishment. The object of both tribunals is the same, namely, that of settling disputes by the judgment of a body of disinterested and fair-minded persons, instead of leaving the stronger to overcome the weaker by force, or of allowing the cunning to victimize the innocent or simple. The experience of centuries has proved the practical utility of courts so composed in settling legal disputes, and every civilized nation has adopted the principle in one form or another. But with respect to labor disputes we are still in a state of barbarism, in which force, fraud, and cunning are always triumphant, and the matter is settled without regard to the merits of the case. Would any one advocate a return to the personal liberty of early days, when barons held their sway and settled disputes by the sword? Yet strikes and lockouts are industrial warfare, and are as barbarous methods of settling labor disputes as the baron's sword was of settling legal disputes.

At present the public does not realize that it has a vital interest in settling labor disputes peaceably, and in providing some competent tribunal for that purpose. The public is good-natured and easy-going, but it will not require many more large strikes and lockouts to arouse its ire. Take the case of a strike or lockout on a railroad or street-car company. These are *quasi*-public corporations, created by the State for the convenience of the public. They are subject to the control of the public; but if a strike or lockout arises, the public may be inconvenienced for days, weeks, or months, simply because there is no tribunal with power to settle the dispute. As the public has the power to remedy this evil, it has only itself to blame for its continued existence.

Nor is the public's interest in settling labor disputes confined to railroading, but also extends to manufacturing, mining, and other businesses. The public is injuriously affected by any act which seriously interferes with the production or distribution of wealth. Strikes and lockouts undoubtedly not only interfere with the production and distribution of wealth, but they also endanger the public peace and security of life and property.

The strong argument of employers is that their business is a matter of private concern, and that therefore they have the right to conduct it as they see fit, without the State's interference. This is true to a great extent. For instance, the employer may decide what business he will adopt, where he will transact it, what goods he will manufacture, when and where and at what prices he will offer them for sale, what persons he will employ, and in many other ways act on his own judgment, uncontrolled by the State or the general public. But when disputes, strikes, and lockouts arise, it is only right that the State should require him to submit the matter to some superior power for determination and settlement. If the public has sufficient interest in a dispute between A and B respecting the ownership of an acre of land, or the liability of B to A for a pair of shoes, to justify the State in compelling them to submit to the decision of a court, it is extremely difficult to understand why the public has not sufficient interest in labor disputes, which frequently entail loss and suffering upon thousands of the public as well as upon the immediate parties to the dispute, to justify the State in requiring the parties to submit to the decision of a State tribunal.

Within the past ten or twelve years the principle of arbitration as a means of settling labor disputes has made considerable progress. The States of Massachusetts, New York, New Jersey, Pennsylvania, Maryland, Missouri, and Montana have all established Boards of Arbitration. The new State of Wyoming has provided in its Constitution for the creation of such a board. By the act of October 1, 1888, Congress legalized a Board of Arbitration, to consist of three members, one to be chosen by each side and the third by the other two, with power to adjust differences between interstate railroads and their employés. Under these various boards some good results have been attained, some labor disputes have been settled, and some strikes and lockouts have been prevented. But the practical value and utility of these boards have been largely impaired by the provision in the law of their organization requiring *both* employer and employed to agree to submit the matter to the board, and also by the failure of the law to confer any power upon the board to enforce its decision or orders. In other words, under existing laws, these boards have jurisdiction only when both sides are willing, and even after the board has rendered a decision, the unsuccessful party may disobey its orders with impunity, as the board has no power to fine or imprison for disobedience. The result is that the board only acts in the small number of cases in which both sides believe themselves right, and never acts in the more numerous and important cases in which one side is conscious of the injustice of its demands. The board's decision has merely a moral but no legal force. The law should be amended in these respects so as to give the board jurisdiction upon the request of a certain number of either side, and with power to enforce its orders—that is, the Labor Board should have the same power over the parties to a labor dispute that a court has over the parties to a legal dispute, and its jurisdiction should not depend upon the consent of both parties. Either side should possess the right to compel the other to submit the matter to the board; and if both sides refuse for a long time to submit to arbitration, and the public interests are endangered, it might be expedient to give a certain number of the public at large the right by request or petition addressed to the board to invoke its jurisdiction. With these powers exercised by a tribunal of disinterested persons it is believed that wages would be raised to the point of fairness, that the honest employer would be protected from the competition of the dishonest employer, that strikes and lockouts would cease, and that the eight-hour day would soon become an accomplished fact.

MICA AND THE MICA MINES.

By C. HANFORD HENDERSON.

ONE can get little pleasure out of a science until one is tolerably familiar with its nomenclature and terminology. We should make even less than we do out of human history if we were not fairly familiar with the language in which it is written. If the words "institution," "government," "constitution" did not convey correspondingly definite ideas, we should be at a loss to interpret the pages of even our more obvious historians. In natural history it is much the same thing, and it is for this reason, I think, that so many make very little out of it. They never get to feel quite at home among the scientific terms which must needs be used. It may seem like insisting upon a very obvious truth to point out that, when we define or describe a thing in terms unknown to the hearer, we do not define or describe it at all; but nevertheless I believe that it is what Mill would have called a luminous platitude. It is certainly a commonplace more noticeable in the breach than in the observance.

A party of two or three are out on a tramp. Perhaps one of the number is a botanist. He is pretty sure to be besieged with questions: What is this?—What is that?—and all asked in evident good faith. One of the tramps picks up a little beach fern and rushes off to the Linnæus of the party to know what it is. Linnæus looks at it, and answers with all good intentions that it is a *Phegopteris dryopteris*. The non-botanical member thanks him, perhaps says, "Oh, is it?" as if it were a perfectly intelligible thing to be a *Phegopteris dryopteris,* and in most cases goes away perfectly satisfied. Occasionally, however, it does occur to him that he is just as wise as he was before, and not one whit more so. These are not imaginary cases. It was from being several times in the position of the non-botanical member that led me to reflect that the function of a definition is to define. Now, who is to blame for this extreme haziness of intercourse, Linnæus or his friend ? Perhaps both of them.

In the face of these experiences, it is difficult to answer the seemingly simple question, " What is mica ? " To say that it is a unisilicate in which the predominant protoxide is potash and the predominant sesquioxide is alumina, is to say something that is fairly unintelligible to those who are not chemists, and something which even to those who are chemists gives only a bit of classification and partial composition, but in reality explains little about the mineral itself. Any answer that we can give is only satisfactory until we learn to push the question a step further. Gautama well expresses the difficuly when he says in the Light of Asia:

> " Shall any gazer see with mortal eyes,
> Or any searcher know by mortal mind,
> Veil after veil will lift—but there must be
> Veil upon veil behind."

But this is a difficulty which besets us on all sides when we question any of the thousand and odd minerals described in Dana, or for that matter when we put questions to Nature in any direction.

In the case of minerals we know enough to perceive that there is much yet unexplained which lies well within the domain of the knowable. But it is as difficult for the mineralogist as for the botanist to give even fair descriptions of the objects of his study, for he so soon runs against his brick wall when he comes to talk about either the physical or chemical properties of minerals. The processes of crystallization are as profound a mystery as the life process itself. We are much in the position of the zoölogists of the last century, who named and labeled their specimens without knowing the significance of their relationship.

The name *mica* is not that of a single mineral, but is a family cognomen, which includes a number of varieties. With the outward attributes of the family we are all more or less familiar, for under the common name of isinglass it forms a small part of the stock in trade of every householder. The family is one of some importance in the mineralogical hierarchy. All are shining members, and are alike in splitting into extremely thin leaves or plates; in being more or less transparent; in being highly elastic; and in having certain ingredients in common. There are seven well-defined minerals* which lay claim to the family name, besides an extensive list of relatives which have been formed by alteration on exposure to air and water. The series runs from the compact, glistening mica found in granite and gneiss, through many gradations of hydrous micas, until we reach the ordinary soapstones and clays. But the name properly stops when the mineral loses its glistening surfaces, for then the Latin word *micare* (to shine) no longer applies. Our German friends call it *Glimmer*, a name whose significance is readily seen.

The importance of the mica family, however, does not depend alone upon its many varieties and numerous relatives. The micas are an essential ingredient in many of our most wide-spread rocks—such as the granites, gneisses, mica schists, and their relatives, which form the continental backbone in both the Eastern and Western worlds. These rocks in time run into each other through infinite gradations, just as the mica passes insensibly into the soapstone, so that we can nowhere find hard and fast lines in the mineral any more than we can in the biological world. If we wish, then, to think of mica correctly, we must picture to ourselves a long stem with many branches, and somewhere on this stem—perhaps midway between quartz and limestone—a group of closely related minerals of peculiar scale-like structure and glistening surfaces. We must think of minerals as momentary crystallizations in an ever-changing current of inorganic matter, and not at all as fixed and final forms.

When we submit the micas to chemical analysis, we find that they all contain a large amount of silica—whose common representative is ordinary quartz—combined with certain metallic bases, such as alumina, iron, magnesia, lime, and the alkalies (potash, soda, lithia, cæsia, and rubidia). No one mica contains all these—though there is some truth in the statement that the micas are silicates of almost everything—but the different varieties depend upon the nature and proportion of the metallic bases which combine with the silica. Thus, while common mica is in the main a silicate of potash and alumina, it also contains small quantities of other metals, such as sodium, magnesium, and iron.

There is a partial parallel here between the mineral and the organic world. Silica is, so far as we know, a compound made up

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* Phlogopite, a magnesia mica, commonly of bronze or copper color.

Biotite, or black mica, a magnesia-iron mica, of dark-green or black color.

Lepidomelane, an iron-potash mica, of black or green color.

Astrophyllite, a rare titanium mica, whose powder resembles mosaic gold.

Muscovite, or common mica, a potash-aluminum compound of varying color, white, gray, brown, green, and even violet or rose.

Lepidolite, or lithia mica, a mineral of pearly luster, and grayish to rose or violet color.

Cryophyllite, a very rare lithium mica, of greenish color.

of two elements, the gas oxygen and the hard, light, non-metal silicon. It is a substance that is almost omnipresent in the rocks of the world. In organisms, on the other hand, it is the carbon which is the chief element, and about which the hydrogen and oxygen and nitrogen group themselves. Silicon seems, then, to play much the same *rôle* in the mineral world that carbon does in the organic. In many respects the two elements themselves are similar. But the point of interest lies in their compounds. Fine, crystallized carbon, the diamond, is not readily altered. Nor are its simpler compounds with the elementary gases, such as carbon dioxide, marsh-gas, and cyanogen. But when the compounds become more complex, when carbon unites with all three of these elements, and the molecule contains many so-called atoms, it is correspondingly unstable. The highest development of this complicated organic structure is found in the human brain, and in the rapid changes which go on in these tissues we have, if not the cause of thought, at least its accompaniment. The quality and quantity of thought apparently depend upon the differentiation of these carbon compounds, and the consequent ease and rapidity with which they can decompose and recompose.

Now, we have in the mineral world at least a partial parallel to this general behavior, and one that is well illustrated in the members of the mica family. Silicon itself is never found alone, and the proximate reason for this is readily understood. It is a fundamental law of chemistry that, when two reactions are possible, that one will take place which will liberate the greater amount of heat. Apply this to silicon. When it unites with oxygen, the heat of combination is very great, greater than that produced by the combination of oxygen with carbon, and consequently this reaction would take place in preference to many others, even in preference to the oxidation of carbon. The point is admirably illustrated by the chemical reactions taking place in the Bessemer-steel process. The pig iron which is run into the converter consists in the main of metallic iron combined with carbon and silicon. When the blast of air bubbles through the molten metal, it is the silicon which first oxidizes. The flame escaping from the mouth of the converter is small and intensely hot. The spectroscope shows a predominance of the silicon lines. Then the carbon flame appears, less hot and more voluminous—the second choice of the oxygen. Finally, the iron itself begins to burn and the blast is discontinued. Bearing these facts in mind, we would never expect to find free silicon, and we are never disappointed. When the element combines with oxygen, in silica or quartz, we have a simple and extremely stable compound, as with the corresponding carbon compound. At a high heat and in the presence of metallic bases, the silica will readily enter into new combinations, as in the processes of glass-making, but in the simple presence of air and water at ordinary temperatures, it remains unaffected through long ages. When the silica is united with a metal, such as aluminum, in kaolin and the ordinary clays, the compounds are still very stable, but they are less so than the simple oxide. When, further, there are several metals included in the compound, as in the mica minerals and their allies, the silicate decreases in stability as it increases in complexity, and we have, as with carbon, a readily decomposable compound.

The world has chosen rock as the symbol of stability, but it has not chosen very wisely, for the majority of rocks are anything but stable.

In the case of the mica family the readiness with which the minerals take up water and part with the more soluble of their components is shown in the many gradations by which they pass through the hydrous micas to the clays and soapstones. It is very noticeable in the mica regions themselves. A mica mine is, indeed, an instructive object-lesson in soil formations. One can almost see the decay of the crystalline rocks going on before one's eyes.

Were the micas only important as a rock constituent, they would doubtless receive very careful study by reason of the many interesting problems which their occurrence and alteration bring up, but in addition to this, their characteristic physical qualities, their transparency, elasticity, laminar structure, luster, comparative infusibility, and electrical non-conducting power, give them a number of applications in the arts, and make them the object of industrial mining. The mica of the market is in nearly all cases the common white mica or muscovite. From its chemical composition it is sometimes known as potash mica, to distinguish it from lithia and other micas, but these names are more common in the laboratory than in trade. Although mica is so widely distributed in Nature, it is only in a few localities and under well-defined conditions that it occurs in large enough plates to be profitably mined. Granite and gneiss both consist of a mixture of the three minerals, mica, quartz, and feldspar (another silicate of potash and alumina), but as ordinarily found, the mica is too thoroughly mixed with the other ingredients, and is in too small masses, to be available. It is only when fissures in the rock have been filled with very coarsely crystallized granite that the mica can be mined with profit.

Such fissure veins occur in a number of localties, notably in Siberia and Norway on the other side of the water; and in our own country, in New Hampshire, in North Carolina, in Wyoming, in New Mexico, in the Black Hills of Dakota, and probably in paying quantities in Alaska. Of late years the importation of mica from the East Indies has been quite heavy and has closed many of the American mines. The recent tariff of thirty-five per cent is leading to their partial reopening.

All these mines are more or less alike so far as their natural features are concerned. The chief differences are artificial, and consist in the methods of mining and handling the mica. The mines of western North Carolina have been largely exploited and may well serve as a type.

As one travels across the State to the westward, one passes over three distinct belts of country: the lowlands, covered by recent alluvial deposits; the middle or Piedmont section, a low plateau underlaid by older sandstones and shales; and, last of all, the western or mountain section, in which the Appalachian system reaches its finest development, and in Mount Mitchell its culminating point. The trend of the rocks in this mountain section is pretty evenly northeast and southwest; they dip at angles which are generally forty-five degrees or over. There are a few mica mines to the east of the Blue Ridge, but the most of them and the best lie to the west. Once beyond this barrier, and evidences of mica abound on all sides. One sees the sunlight reflected from plates of mica on distant hill-sides, and the glitter of tiny scales in the bed of every brook. These look so much like gold that one is tempted to turn Argonaut, and try to bring again the golden fleece. For Colchis, it is easy to read Carolina. The talcose schists and slates of the eastern escarpment are here succeeded by the oldest crystalline rocks of the continent, belonging presumably to the Huronian or Laurentian period. There are giant upthrows of granite and gneiss, and these are full of fissures carrying the coarsely crystallized matrix in which the pay mica is found.

It must not be thought, however, that all these veins are alike profitable, or even that the same vein can be relied upon for any great distance, for that would be far from the experience of the practical mica-miner. It is indeed impossible, even after this lapse of time, when some of the mines have been worked intermittently for more than a quarter of a century, to reach any general conclusions as to what conditions are most favorable for a profitable mine. Old miners say that this or that indication is a sure sign of a good mine, but the shrewdest of them confess that mica-mining is pretty much like gambling. A certain amount is staked in the shape of labor and supplies, and one gets in return either hundreds of dollars' worth of mica, or perhaps only barren quartz and feldspar.

Many of the veins occur in a fine-grained black gneiss, which passes with the mountain miners under the name of "slate." The vein generally dips with the bedding of the gneiss, but occasionally it changes abruptly and cuts across the strata. In some of the mines the vein does not come to grass, as the miners say, but only begins some distance below the surface. The veins vary in thickness from less than an inch to ten or a dozen feet, occasionally to as much as thirty or forty feet, but these instances are rare. In places the vein pinches out completely and is practically lost, or is cut off perhaps by a large mass of displaced country rock, known as a "horse."

The contrast between the vein stuff and its containing walls is very striking and often very beautiful. The "slate" is almost black, and is generally clean and glistening, while the vein itself is almost snow-white. This is due to the feldspar with which the fissure is filled. It breaks with a clean, smooth cleavage, and shows on such surfaces a brilliant, pearly luster. The dump-heaps around the mine-mouth are largely made up of this dazzling white feldspar. One is constantly tempted to fill every available pocket with the mineral, to the exclusion of other specimens really more interesting. Interspersed with the feldspar are masses of grayish-white quartz and occasional blocks of the coveted mica.

It would be of the highest value to know how these three minerals got into the vein and arranged themselves in their present form, but, as no direct observation is possible, we can only reason back from such facts as we are now able to observe. The fissures themselves are doubtless simple cracks formed by those shiftings and readjustments which are constantly going on in the surface rocks of the earth. The vein material has evidently been intruded from below and has come in a liquid or pasty condition, but just how it has come, and whether as a uniform mass which afterward separated into the different minerals, or as a mixture in which each mineral still preserved its own identity, we are quite unable to say. The most reasonable supposition is that the material came into the vein in a condition of aqueo-igneous fusion—that is to say, rendered liquid at a comparatively low temperature by the presence of water and great pressure—and that it was fairly homogeneous. The question as to which mineral separated first would seem almost hopeless. Yet there is quite strong circumstantial evidence to show that the mica was the first to form, for the mica is much more uniformly crystallized than either of the other two minerals, and frequently leaves the impress of its lamina on the crystals of quartz. After the mica, the feldspar probably separated; and, last of all, the silica that was left over after the formation of these two minerals, collected into crystals of quartz. This is what we would expect theoretically. The mica is only about half silica, the feldspar a little over two thirds, and the quartz manifestly nearly all silica. The minerals containing the greater amount of metallic bases would naturally separate first.

The location of the mines has been largely accidental. So far as I have been able to learn, the first one opened was the Sink-hole mine in Mitchell County. The spot was marked by the existence of trenches, many hundred feet long in the aggregate, and in places fully twenty feet deep. Large trees growing on the *débris* indicated that the workings were very ancient. It was supposed that they had been for silver; and when the trenches were reopened at the close of the war, the search was for that metal and not for mica. Silver seems to dominate in the Carolinian dream of mineral wealth, when it is, of all such dreams, the one least likely to be realized. The search for silver being unsuccessful, the mines were again abandoned. The mica that had been thrown out was left on the dump, and soon advertised the real character of the mine. A stock-driver, passing that way, carried a block of it with him to Knoxville, where it attracted the attention of men acquainted with its value. They investigated the matter, emigrated at once to Mitchell County, and began systematic mining for mica. As the mineral was then selling for from eight to eleven dollars a pound, the rewards were considerable, and much enterprise was shown in the development of the industry. The first-comers had the easy and profitable task of simply preparing and shipping the mica that had been already mined, and they enjoyed the further advantage of an undisturbed market. So profitable an enterprise, however, soon attracted others. Many of the hands employed in the mines were also land-owners and naturally concluded, as soon as they had learned something of the business, that it would pay better to work for themselves. They began exploring their own plantations, and as these often contained several hundred or even several thousand acres, the ground for prospecting was extensive. It is a region in which the majority of the people are land-poor. The single-tax project would not be apt to meet with favor there.

Then, as now, the mountaineers were largely guided in their search by the ancient workings. These were probably made by the aborigines, and were also for the purpose of obtaining mica. The old workers could only penetrate as far as the rock was decomposed, and were obliged to stop as soon as solid ground was reached. The imprint of their stone implements may still be seen in the decomposed stuff at the sides of the opening. What these people used the mica for is still problematical. Large plates of it have been found in the mounds of Eastern Tennessee, and would indicate that it had domestic application, or was used for personal decoration.

In the absence of these archæological landmarks, there are other signs scarcely less unmistakable. On exposure to the atmosphere the feldspar is decomposed, the potash being washed out, and the kaolin left as an insoluble residue. If this be followed up, it is pretty sure to lead to mica, but one can not, of course, predict to what sort of mica.

In most cases the mining has been decidedly incidental in its character, and has been abandoned as soon as water was reached, or as soon as the yield of mica ceased to be immediately profitable. Other mines have had quite a history. Perhaps the most famous of the Carolina mines is the Clarissa, near Bakersville. It was opened soon after the Sink-hole, and is said to have produced more mica than all the other mines in the county combined. Its output is reckoned up in hundreds of thousands of dollars. The vein is from four to twelve feet thick, with an average of about six. It has been followed to a depth of over three hundred feet. The mine is now idle and full of water, although men who know it say that there is as much mica there as ever.

With labor at seventy-five cents a day, the primitive methods of mining are the more profitable. Steam drills have been introduced in a number of the mines, but have proved less economical than hand drilling. I do not know that the relation is strictly that of cause and effect, but their introduction has generally been followed by the closing of the mine. When the vein stuff has been blown down, it is an easy matter to separate the blocks of mica from the feldspar and quartz. When once obtained they are jealously guarded, for a clear block of mica of good size represents a value of many dollars. Each mine has its strong-room, solidly built of logs and constantly kept under lock and key. These blocks of mica are in the shape of rough hexagonal prisms (monoclinic), and if of any thickness are quite opaque. They vary in color from silver-gray and green to a rich, almost ruby brown. This last is known as "rum" mica, and sometimes commands an extra price.

The mica is seldom prepared for market at the mine itself, but is taken to a conveniently located glass-house. This generally means a transportation of several miles. Frequently the mines are on steep mountain-sides, and are only connected with the outside world by the roughest sort of trails. In this case the mica is "packed" down the mountain on the backs of men to the wagon-road in the valley below.

At the glass-house the mica is put into shape for shipment. The blocks vary greatly in size. One from the Wiseman mine, near Spruce Pine, is reported to have been six feet long by three wide. Pieces a yard in diameter have been obtained at the Ray mine, in Yancey County, and similarly large plates have been found in Siberia, but these are exceptional. The average block is little larger than the page of a magazine, and is generally less than six inches in thickness. It separates very readily into sheets parallel to the base of the prism. It is estimated that this cleavage may be carried so far that it would take three hundred thousand of the mica plates to make an inch. It is needless to say, however, that such a thickness is not suitable for service in stoves and furnaces. The mica is generally split into plates varying from about one eighth to one sixty-fourth of an inch in thickness. In preparing these plates for market, the first step is to cut them into suitable sizes. Women are frequently employed in this work, and do it as well as, if not better than the men. The cutter sits on a special bench which is provided with a huge pair of shears, one leg of which is firmly fixed to the bench itself, while the movable leg is within convenient grasp. It is requisite that the shears shall be sharp and true, for otherwise they will tear the mica.

The patterns according to which the mica is cut are arranged in a case near at hand. They are made of tin, wood, or pasteboard, according to the preference of the establishment. Generally they are simple rectangles, varying in size from about four square inches to eighty. The following table, taken from actual use, will give some idea of the numerous sizes cut, and of the theoretical prices which correspond to them. The actual prices are at present about forty per cent less:

Size.	Price per lb.	Size.	Price per lb.	Size.	Price per lb.	Size.	Price per lb.	Size.	Price per lb.
1½ × 3	$0 50	2 × 2¾	$0 60	2¼ × 4¾	$2 00	2¾ × 3	$1 00	3 × 7	$8 50
1½ × 3¼	55	2 × 3	65	2¼ × 5	2 40	2¾ × 3¼	1 20	3 × 8	8 75
1½ × 3½	60	2 × 3¼	70	2¼ × 5¼	2 50	2¾ × 3½	1 35	3 × 9	9 00
1½ × 3¾	65	2 × 3½	80	2¼ × 5½	3 00	2¾ × 3¾	1 50	3¼ × 3¼	3 50
1½ × 4	75	2 × 3¾	90	2¼ × 6	3 40	2¾ × 4	1 75	3¼ × 3½	4 00
1½ × 4¼	85	2 × 4	1 10	2¼ × 6¼	3 65	2¾ × 4¼	2 25	3¼ × 3¾	4 50
1½ × 4½	1 00	2 × 4¼	1 20	2¼ × 6½	3 90	2¾ × 4½	2 75	3¼ × 4	5 00
1½ × 4¾	1 25	2 × 4½	1 40	2¼ × 7	4 25	2¾ × 4¾	3 50	3¼ × 4¼	5 25
1½ × 5	1 50	2 × 4¾	1 50	2½ × 2½	70	2¾ × 5	4 50	3¼ × 4½	5 50
1½ × 5½	1 90	2 × 5	1 75	2½ × 2¾	75	2¾ × 5¼	4 75	3¼ × 4¾	6 25
1½ × 6	2 40	2 × 5½	2 40	2½ × 3	85	2¾ × 5½	5 25	3¼ × 5	7 25
1¾ × 2	50	2 × 6	3 00	2½ × 3¼	95	2¾ × 6	5 75	3¼ × 5¼	7 50
1¾ × 2¼	50	2 × 6½	3 50	2½ × 3½	1 00	2¾ × 6½	6 25	3¼ × 5½	7 75
1¾ × 2½	50	2 × 7	4 00	2½ × 3¾	1 20	2¾ × 7	6 75	3¼ × 5¾	8 00
1¾ × 2¾	50	2 × 7½	4 25	2½ × 4	1 30	3 × 3	1 80	3¼ × 6	8 50
1¾ × 3	60	2 × 8	4 50	2½ × 4¼	1 60	3 × 3¼	2 15	3½ × 3½	4 50
1¾ × 3¼	65	2¼ × 2¼	50	2½ × 4½	2 25	3 × 3½	2 60	3½ × 3¾	5 00
1¾ × 3½	75	2¼ × 2½	55	2½ × 4¾	2 75	3 × 3¾	3 00	3½ × 4	5 50
1¾ × 3¾	90	2¼ × 2¾	60	2½ × 5	3 50	3 × 4	4 00	3½ × 4¼	5 75
1¾ × 4	1 00	2¼ × 3	70	2½ × 5¼	3 60	3 × 4¼	4 75	3½ × 4½	6 50
1¾ × 4¼	1 10	2¼ × 3¼	85	2½ × 5½	3 75	3 × 4½	5 50	3½ × 4¾	7 00
1¾ × 4½	1 25	2¼ × 3½	95	2½ × 6	4 25	3 × 4¾	6 00	3½ × 5	7 50
1¾ × 4¾	1 40	2¼ × 3¾	1 10	2½ × 6½	4 50	3 × 5	7 00	3½ × 5½	8 25
2 × 2	50	2¼ × 4	1 25	2½ × 7	5 00	3 × 5½	7 50	3½ × 6	8 75
2 × 2¼	50	2¼ × 4¼	1 50	2½ × 8	5 50	3 × 6	8 00	3½ × 6½	8 75
2 × 2½	50	2¼ × 4½	1 75	2¾ × 2¾	85	3 × 6½	8 25	3½ × 7	9 00

Size.	Price per lb.	Size.	Price per lb.	Size.	Price per lb.	Size.	Price per lb.	Size.	Price per lb.
3½ × 8	$9 25	4 × 5¼	$8 00	4½ × 5	$8 25	5 × 8	$10 25	6 × 9	$11 00
3½ × 9	9 50	4 × 5½	8 50	4½ × 5½	8 75	5 × 9	10 50	6 × 10	11 50
3¾ × 3¾	5 50	4 × 6	9 00	4½ × 6	9 25	5 × 10	11 00	7 × 7	10 75
3¾ × 4	5 80	4 × 6½	9 25	4½ × 6½	9 50	5½ × 5½	9 25	7 × 8	11 00
3¾ × 4¼	6 25	4 × 7	9 50	4½ × 7	9 75	5½ × 6	9 75	7 × 9	11 25
3¾ × 4½	6 75	4 × 8	9 75	4½ × 8	10 00	5½ × 7	10 25	7 × 10	12 00
3¾ × 4¾	7 25	4 × 9	10 00	4½ × 9	10 25	5½ × 8	10 50	8 × 8	12 00
4 × 4	6 25	5¼ × 4¼	6 75	5 × 5	8 50	5½ × 9	10 75	8 × 9	12 50
4 × 4¼	6 50	4¼ × 4½	7 25	5 × 5½	9 00	6 × 6	10 00	8 × 10	13 00
4 × 4½	7 00	4¼ × 4¾	7 75	5 × 6	9 50	6 × 6½	10 25		
4 × 4¾	7 50	4¼ × 5	8 00	5 × 6½	9 75	6 × 7	10 50	All larger at	
4 × 5	7 75	4½ × 4½	7 50	5 × 7	10 00	6 × 8	10 75	special prices.	

The cutter selects the pattern which will cut to the best advantage, lays it on the sheet of mica, and then, holding the two firmly together, trims off the edges of the mica to make it correspond with the pattern. She puts both mica and pattern in their proper place in the case before her. Then she takes up another piece of mica, and finding the best pattern, proceeds to shape the sheet as before. In this way the rough plates of mica are reduced to uniformity and are sorted as they are cut. When the cutter completes her task, she has all the mica piled away in little bundles under their corresponding patterns, while the scrap falls in a glistening heap on the floor.

The cleaning process comes next. The cleaner sits directly in front of a window and must examine each sheet of cut mica by holding it up between her eyes and the light. If there be any imperfections, and there nearly always are, they must be removed by stripping off the offending layers of mica until a clear sheet remains. The cleaning is done by means of a sharp penknife—and considerable discretion. It is quite easy to tear away the entire sheet and have nothing left for one's trouble. Both the cutting and cleaning are tiresome routine operations, yet there is a certain fascination about tearing the mica to pieces that few have philosophy enough to resist. One soon becomes absorbed in the task of seeing just how thin a sheet of mica can be separated, and before one realizes it an hour or more is gone.

Finally, the cut and cleaned mica is put up in pound packages and is ready for the market.

There is an enormous waste in the processes of preparation. One hundred pounds of block mica will scarcely yield more than about fifteen pounds of cut mica, and sometimes it is even less. The proportion varies, of course, with different localities.

The chief use of the cut mica is in stoves, and its comparative cheapness has made possible the luminous—not to say artistic—wonders which constitute the latest and most cheerful creations of the stove-men. In Siberia the sheets of mica are still sometimes used in windows, as they were in the seventeenth century in Philadelphia, when glass was a luxury in the colonies. The sheets are also used in the peep-holes of smelting furnaces, in lanterns, in shades, and in the port-holes on board naval vessels, where the vibrations would soon demolish less elastic glass. Mica is an excellent non-conductor, and of recent years has been cut to some extent into narrow strips for use in the construction of dynamos.

The scrap mica was formerly thrown away, with the exception of a small quantity used as a lubricating material, but it has recently found a market in several new directions. Old waste heaps are being bought up, for a few dollars a ton, and their contents cleaned by being passed through a rough mill. This is simply a rotating cylinder of coarse wire screen with its axis slightly inclined to the horizontal. The scrap is fed into the upper end of the cylinder, and slowly discharges itself from the lower end. As it makes its way from end to end, the sand and trash are supposed to fall through the meshes of the screen. The cleaned scrap is then shipped to Richmond, where it is ground into a coarse powder and distributed to the various industries requiring it. Large quantities are used in the manufacture of wall-paper. The mica produces a sparkling surface which is thought to be decorative, but at best the effect is somewhat bizarre. Considerable amounts are used to produce the snow effects on Christmas cards, and in stage scenery and other tinsel; while smaller packages, under the name of diamond dust, are sold as powder for the hair. Much of the ground mica is sent to France, and this, oddly enough, when the East Indian sheet mica is pressing our own pretty heavily in the home market.

The Latin world used the mica dust to strew over the Circus Maximus, while mediæval Europe knew the golden and silver scales as cat-gold and cat-silver.

But to go back again for a moment from the glass-house to the mines themselves, there is much of interest in the rare and beautiful minerals associated with the mica. Some of the mines are quite noted for these by-products and are as attractive to a lover of color as to the mineralogist. The mica itself is often the carrier of curious forms. Frequently a mineral makes its way between the laminæ of the mica, and is thus forced to grow horizontally instead of normally in three directions. This gives us curious dendritic or tree-like forms which come out finely on holding the mica up to the light. The oxide of manganese is most prone to get caught in this way, and gives delicate tracery of dark brown or black. Sometimes it is a garnet which is thus entrapped, and then we have a brilliant little hexagonal plate of ruby glass, very beautiful and very gem-like. By carefully taking off the outer sheet, we can get the garnet-plate set in mica, and it makes a specimen well worth preserving. Less frequently one finds a thin layer of quartz imprisoned between the mica, or a thin layer of the transparent glassy feldspar known as sanidin. Sometimes the mica itself is microscopically striated, and plays queer tricks with the light, giving iridescent films that might easily be mistaken for soap-bubbles.

But the feldspar is the most promising matrix for the mineral hunter. At the Cloudland mine it is well penetrated with the greenish, yellowish, and bluish hexagonal prisms of the beryl. The precious form of this mineral, the emerald, is seldom or never found in the mica mines. There is, however, an intermediate variety known as the aqua marine, which occurs in the mines around Spruce Pine, and is somewhat esteemed as a gem. As the name indicates, it is of a light sea-green color. It is perfectly transparent, and when well cut makes a quiet but really beautiful gem-stone. Clear crystals of aqua marine are exceedingly rare. It comes commonly as a part of the opaque crystal of beryl.

Intimately associated with the beryl are plentiful sprinklings of blood-red garnets, and the two colorings against the pure white background of the feldspar make a very effective combination. Garnets are generously distributed in nearly all the mica mines, and add much to the beauty of these mineral masses. One day at the Cloudland mine, a large mass of feldspar was blown down, and there in the center of the white and standing face of the vein was a blood-red spot at least six or seven inches in diameter. A giant garnet had been cut squarely in two by the blast, and the blood-red spot was a cross-section of what remained.

In other mines, such as the Tolly Bend in Yancey County, the white feldspar is occasionally covered with patches of dainty pink. It is the mineral rhodonite, a silicate of manganese, and is as delicate as a peach-blow vase.

There are also other accessory minerals which are less striking in appearance, but of greater scientific interest on account of their rarity. Such are euraninite, gummite, columbite, and samarskite, containing the rare metals uranium, columbium, yttrium, tungsten, tantalum, and their allies, which are curiosities even to the chemist. At Spruce Pine, one gets excellent specimens of uraninite, the oxide of uranium. It is a heavy black mineral with a frequent orange-yellow coating of another uranium compound, gummite. The miners take considerable interest in finding the mineral, as it is worth something like a couple of dollars a pound, and it takes a very small quantity to make a pound. The oxides of the metal are used to produce black and yellow colors on glass and porcelain. The peculiarly fine black of Haviland china is due, I believe, to uranous oxide.

The Ural Mountains are the collecting-grounds for the cabinets of Europe. In no other district can one find so many varieties of minerals within the same area. The mountains of western North Carolina are in many respects similar. They probably yield a greater number of rare minerals than any other region in America, and are therefore a favorite tramping-ground for collectors. At the smallest cross-roads post-office one hears of the visit of some well-known mineralogist. Nearly every mountaineer has a few specimens in his treasury, and generally he knows the names of the more characteristic varieties, particularly if they have a marketable value. It is not safe, however, to rely very implicitly upon his classification, for his knowledge is of the most superficial sort.

As commonly taught in our schools and colleges, and as commonly apprehended by students outside, a knowledge of mineralogy consists of a more or less definite familiarity with several hundred minerals, and an ability to recognize the more common varieties on sight, or by means of some readily applied physical test. It is largely a knowledge of separate and unrelated facts, a catalogue, one might almost say, and not yet a body of well-organized truth. We have gathered part of the material of a fine science, and eminent men are now at work building this material into a coherent whole. The curious facts of paragenesis, or the characteristic associations of minerals, and the many problems presented by substitution and alteration, are being carefully investigated. The mysteries of crystallization are commanding attention. The progress along these lines is very encouraging. But a great amount of work still remains to be done. One who comes to the study of minerals at this particular juncture will find it pleasurable, even as a study of separate facts, but he will feel, I think, that a greater pleasure remains for him when these results have been still further co-ordinated. We are still waiting for our Darwin.

Statistics concerning the influence of the style of living on stature, collected by M. G. Cartier from among the conscripts at Évreux, France, go to confirm the conclusions that other authors have drawn on the subject. Persons who are supposed from their occupations to have been brought up under good hygienic conditions and comfortable circumstances—students, farmers, etc.—are generally of larger than average stature; while persons ill-fed, poorly clothed, or who have grown up in an unfavorable medium—workers in metallurgy, weavers, etc.—are smaller. Consequently, if "the race fixes an ideal mean round which individuals oscillate," the latter are especially influenced by the conditions of the medium, alimentation, exercise, and comfort.

INCALCULABLE ACCIDENTS.

By WILLIAM A. EDDY.

WHEN we consider the quantity of metal and the jars and strains to which it is subjected as railroad trains move at high speed, it becomes difficult to estimate the effects of accidents and to think of a way to evade injury. When caught between trains rapidly passing each other it is claimed that if the incautious pedestrian remain standing the result will be disastrous, and that safety is assured only by lying down. This peculiarly perilous situation illustrates a simpler phase of the complications that may arise when an accident is imminent, in which the danger may be principally due to the fact that the noise and interposition of one train conceal the presence of another.

The surprising and unexpected nature of some railroad accidents was exemplified in the experience of the engineer of a passenger train which was moving at the rate of about forty miles an hour. He felt a jar and heard a terrific clatter beneath his locomotive. At the same time he was astonished to find that the seat on the other side of the engine cab where the fireman usually sat had been torn away, and the fireman thrown backward and left insensible. The engineer instantly knew that one of the bars connecting the driving-wheels of his locomotive had broken. The partly detached piece of steel beat against the cab with severe blows caused by the rapid revolutions of the wheels. He jumped to his feet to escape injury, just as the bar on his side of the locomotive broke also and tore away the seat which he had vacated. The crippled locomotive was then derailed, causing general destruction of the running gear and woodwork of the cars.

This derangement in the mechanical structure of a locomotive occasionally happens, and it is one of the possible accidents that every locomotive engineer must guard against. It is clear that familiarity with special machinery sometimes lessens the fatality due to an accident, because the resulting effects have been looked for during many years, and the action to meet the conditions decided upon. But the complication is increased by the fact that each accident may be unprecedented. For example, at another time the side-bar broke away from the driving-wheels altogether, and, striking against a jutting point of rock, bounded beneath the train, which was under full head-way. This long, powerful piece of steel then flew along the track under the train and pierced a hole through the floor of the rear car. Meantime the brasses and some of the more delicate machinery on the forward part of the locomotive were torn away and, falling on the track or rails, threw off the last four wheels of the rear car, which was dragged in a slanting position, plowing up the gravel, for about a thousand feet along the edge of a high embankment. The occupants of that car never forgot the awful sensation, like that of a violent earthquake with its resulting uncertainty of footing. A striking characteristic of this accident was that the engine and forward car were not thrown from the track. Another accident of this kind, equally unexpected, took place under somewhat similar conditions, when one of the driving-wheels burst with terrific explosive force, a solid piece of the iron crashing through the woodwork of a passenger car, after having shattered the glass of a door. This ponderous missile shot along the aisle between the car seats, unpleasantly near the heads of the passengers.

The sign on many car doors notifying passengers not to ride on the car platforms calls attention to a danger which is more real than may be at first supposed. Some people who easily lose their balance may be thrown off a train, owing to the sudden jar of the cars at the beginning of a sharp curve, and the same effect may be brought about by the stopping and starting caused by coupling cars. In one such instance a man was thrown from the rear platform as the train made a jerking movement forward. There is also the possibility of a fall due to dizziness or momentary faintness. But probably the most remarkable case recently recorded occurred during a very high wind when a passenger was blown from the platform of a car which was running across the wide, windy expanse between Jersey City and Newark, New Jersey.

There is marked danger in trying to board a moving train, as shown by repeated accidents; yet so irresistible is the temptation to do this that it would be difficult to find a man who has not taken the risk. The car steps, as related to the position of an ordinary station platform at the level of the rails, are too high to be easily gained, and the rails over which the wheels of the car are to pass are nearer the edge of the car steps than is generally supposed. If, owing to miscalculation, haste, or a stumble, the passenger's foot is placed under instead of upon the step, the result may be fatal, because the movement of the body when swinging from the perpendicular railing at the corner of the car is then toward a position beneath the car platform. It is probably safer to jump from a rapidly moving train than to board the same train. The extent of the peril in leaping from a moving car obviously depends upon the amount of skill shown in alighting upon ground that slants away from the track. Of course, the many serious accidents caused in this general way suggest the radical importance of waiting for a train to stop.

The rules pertaining to the safety of passengers using the great transportation lines seem at times needless. But the movements of people who are distracted by trouble, who are absent-minded, excited, mentally disordered, almost crazed by an amazing success as well as by an equally amazing failure, may be characterized by incalculably erratic action, even if the action be decidedly exceptional. Such people may have little more than the power of ordinary locomotion. In many instances, owing to the unprecedented nature of the occurrence, the individual at his best can not cope with the conditions. Some accidents may take place only once in a lifetime, and the person threatened is necessarily unable to instantly decide upon the wisest course.

Accidents may be dealt with coolly by the professional man, or the coroner who attends like cases. The growing complications of modern life are such that the highest form of natural shrewdness is almost inoperative under these rare circumstances when compared with experienced intelligence.

The modern railroad train, with its tremendous momentum, calls for a greater number of mechanical engineers of superior ability whose ingenious constructive power shall further lessen not only the danger but the amount of destruction caused by railroad accidents. Prevision of the effects of an accident may involve the elaborate calculations necessary to the solution of an intricate mathematical problem. In fact, the contingent or possible results in a given instance suggest the importance of long and careful training. Undoubtedly, with the lapse of time, and with wider experience, the imperfections in railroad construction and material will steadily decrease.

The accidents from contact with electric-light wires that carry a deadly current are well known, but the complex nature of these accidents demands special attention. Sometimes the attempt to close an iron door or an iron window shutter is at once followed by a severe electric shock, if not by serious injury. The men who repair ordinary telegraph wires have learned to be cautious because of the possible presence of a deadly current. An operative who was accustomed to the work of readjusting dangerous wires was killed because, unknown to him, an apparently disused, rusty wire was charged with intense electric force, as evinced by the fact that a metal cornice, wet with rain, carried the current from the wire through his body. A somewhat similar accident occurred to a skilled electrician who was connecting one wire with another on a switchboard. He lost his balance while on a step-ladder, and, as he put out his hand to save himself, he by chance touched another wire, and this completed a circuit that killed him instantly. Still another phase of this kind of accidental death from electricity was seen in New York city when an Italian, who was cleaning a window, completed a circuit from his hand through his body, the current penetrating the sole of his shoe which rested upon a metal surface. A like accident, singularly fatal, happened to one of two clerks who had lifted a metal show-case to carry it into a store. The metal top of the case touched the metal extension of an arc electric lamp that had been left hanging too near the pavement. One of these clerks, moving hurriedly under the strain of the burden, chanced to step upon an iron cellar grating which caused the electric current to kill him instantly. The other clerk, who was lifting his part of the weight, stood upon the ordinary pavement and so was not injured. The metallic frame of the show-case had transmitted the current.

Some very serious injuries have been caused by an attempt to brush away an electric-light wire that dangled against the head of the passer-by. The muscles of any one who is unfortunate enough to grasp such a wire contract with uncontrollable persistence, and the electric current burns with an effect resembling that of white-hot iron.

The innumerable electric appliances, which are already beginning to compete with those run by steam, must increase the number of accidents. Rapidly growing power is at present accompanied by rapidly growing risk—a condition to be expected during early stages of advancement. But relative safety will doubtless be attained through the skill of an army of specialists who will be divided and subdivided into a greater number of groups as the new combinations multiply. Herbert Spencer's doctrine of the increase of heterogeneity during certain stages of evolution is thus reaffirmed in this age of mechanism. Yet there is every reason to expect that the development of intelligence will steadily eliminate the dangers arising from haste in construction. The loss and inconvenience which may be experienced while waiting for absolute safety should not be overlooked. In fact, prolonged delay is neither practicable nor desirable.

In his introductory lecture on the Anthropological History of Europe, Dr. Beddoe inclines to the modern view which regards Europe as the original home of the Aryans. He also discusses in a novel manner some of the causes which may be supposed to produce changes of physical type. Incidentally he records his opinion that a process of selection, which may be called natural, works against the perpetuation of certain types in our cities. He also remarks that more evidence exists than is generally known of the deteriorative effect of malaria on physical type.

The Antarctic Fund of the Australian Association for the Advancement of Science has grown to £14,044, leaving only £1,000, or $5,000, to raise it to the £15,000 that are sought to complete it. It is thought that this remaining amount will be furnished by the colonial governments. As at present arranged, the expedition is expected to arrive in September, 1893, at its last coaling port and starting-point in the southern hemisphere.

TOBACCO AND THE TOBACCO HABIT.

By M. JULES ROCHARD,
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THE use of tobacco prevails throughout the whole world. Smokers alone are numbered by hundreds of millions. A million and a quarter acres of the earth are devoted to the cultivation of the plant, and the taxes on it alone in France amount to three hundred million francs (or sixty million dollars). A custom so general, a habit that has been maintained so long in the face of constant attacks upon it, should be considered seriously. It should be studied from every side, and the various elements of the question should be subjected to a complete analysis by the means of investigation now at our disposal, for it is a scientific problem of the first order. While it is of moral and philosophical interest, and its social consequences are within the province of economists, it is for science, physiology, and hygiene to furnish experimental data as the basis for their deductions.

A proper study of the subject should be made with an independence of prepossession which it is not easy to find. Persons who have never smoked will talk of tobacco as the blind talk of colors; smokers have a fondness for their habit, while those who have been obliged to give it up are prejudiced on the other side. I am one of the reformed smokers. After having abused tobacco for about fifty years, I was compelled to abjure it. I fought my ground inch by inch, and yielded only to an absolute necessity. Knowing what the reformation cost me, I have not tried to make proselytes; but I intend to say what I believe is true upon a question which I have studied well, and on which I am not lacking in personal experience.

The tobacco plant belongs to the order *Solanaceæ*, and constitutes a genus (*Nicotiana*) named after Jean Nicot. It is cultivated through the whole world, and succeeds equally in the temperate zone and the intertropical regions. Two species are cultivated: common or large tobacco (*Nicotiana tabacum*) and small tobacco (*Nicotiana rustica*). The first species is the most widely diffused. It is a large and fine-looking annual plant, growing to a height of about six feet. It bears large alternate leaves of a glaucous-green color, and is tipped with a cluster of elegant flowers having a pale-rose corolla and a persistent five-parted calyx. Small tobacco does not exceed twenty inches or two feet in height. Its leaves are thick, soft, dark-green, and viscously hairy. The terminal inflorescence comprises clusters of flowers composed of cymes. The pale-yellow corolla, a little greenish, is supported by a campanulate calyx, covered with glandular hairs and terminating in uneven teeth. The genus *Nicotiana* includes some fifty other species, mostly natives of America, but some of Australia and the islands of the Pacific Ocean. Of these, some fifteen or twenty species are cultivated and give rise to different foreign tobaccoes, the taste and properties of which are varied. A few species, remarkable for the richness of their colors and their graceful growth, are cultivated as ornamental plants in gardens.

Tobacco leaves contain principles common to all vegetable substances—such as starch, cellulose, sugar, organic acids, and salts—principles soluble in ether, nitrogenous substances, and a peculiar alkaloid to which the plant owes its special qualities, called *nicotine*. This alkaloid, discovered by Posselt and Remann, was isolated by Vauquelin in 1809. It is an oily liquid, transparent and colorless, which becomes brown and thick in the air by absorbing oxygen. Its acrid and virulent odor is like that of tobacco; it has a burning taste, and its vapor is so irritating that breathing is painful in a room where a drop of it has fallen. It is very hygrometric, and soluble in water, alcohol, and ether. It combines directly with acids, with the evolution of heat. It is found as a malate in the leaves. The different kinds of tobacco do not contain the same quantities of it. The black, unctuous tobacco of the Antilles, the pronounced savor, ready burning, and white ash of which make it in demand among experienced smokers, contains much more nicotine than the light, fragrant tobacco of the Levant. The quantity of it increases with the development of the plant, and varies according to the thickness of the leaves. The thinner-leaved plants contain less of it. The fermentation to which tobacco is subjected in manufacturing volatilizes a part of the nicotine and substitutes ammonia for it. Consequently, there is less nicotine in tobacco prepared for consumption than there was in the dry leaves before the preparation. Combustion destroys about three quarters of this. According to M. Pabst, the smoke of five grammes of tobacco yields about three milligrammes of nicotine; but it contains a number of other principles besides, the enumeration of which here would not be interesting. Nicotine is the active principle of tobacco, as atropine is of belladonna and morphine of opium; but there are other poisons among the substances united with it. The less volatile ones condense during combustion, and produce a brownish empyreumatic liquid, a kind of coal-tar of tobacco, a part of which oozes through porous pipes, and the whole of which is retained in the water of nargilehs.

Among the volatile principles that pass into the smoke along with nicotine are hydrocyanic acid and carbonic oxide. Dr. Grehant has shown that a notable quantity of them is absorbed by rapid smokers swallowing the smoke, and the gas passes into the stream of the circulation. These facts are of considerable importance in view of practical consequences, and go far to explain the accidents that sometimes occur after one has passed several hours in a medium saturated with tobacco, even without smoking, and the phenomena of intoxication which are produced by eating food that has remained for a long time in a similar atmosphere.

Tobacco is a poison, as are most of the *Solanaceæ* and many plants which medicine daily utilizes. Its properties have been studied in our time with all the rigor of the experimental method, verified by clinical observation. We can no more than present the principal results of the investigation here. The decoction of tobacco destroys animal life in a time short in proportion to the strength of the dose. The phenomena preceding death are like those produced by other toxic alkaloids, and are identical with those exhibited by man in a similar condition, which doctors have had too frequent occasion to observe. Sometimes convicts or sailors swallow their quids, or fools drink on a wager a glass or two of the empyreumatic juice that flows from old pipes, or the poison is swallowed by mistake, as when snuff is taken for coffee or tobacco leaves are mixed with orange leaves. Cases of malicious poisoning are more rare; but the poet Sauteuil died, according to Merat, in horrible suffering after having drunk a glass of wine in which Spanish tobacco leaves had been put. Mortal poisoning is, however, rarely brought about when tobacco is taken by the mouth, for it is nearly always rejected by vomiting before it can produce its worst effects; but the results of intestinal administration are different. The intoxication is then most usually the result of a medical error. The decoction of tobacco is still given sometimes as an injection in cases of asphyxia by submersion or of strangled hernia, and, if the dose is too large, death may result. Orfila cites four cases that were fatal in doses ranging from eight to sixty-four grammes. One patient died in fifteen minutes, and the one who held out longest at the end of two hours. Eight grammes do not form a toxic dose, but the case cited by Orfila was one of an infant. From fifteen to thirty grammes are required to kill an adult. Tobacco may also poison through the lungs. Cases are mentioned of persons who died from sleeping in a room filled with fermenting leaves; others, worthy rivals of the bettors just now spoken of, died after executing wagers that they could smoke an improbable number of pipes without intermission. The skin itself may serve as a channel for the introduction of the toxic principle. Accidents of this kind were not rare when diseases of the skin were treated with pomades or liniments of which tobacco was the base. Murray reports an observation of three infants who were taken with vomitings and vertigos, and died in convulsions within twenty-four hours after having their heads rubbed with a tobacco ointment. Cases are recorded of smugglers who died after having covered the bare skin of their whole body with tobacco leaves which they were trying to introduce fraudulently. Ferdinand Martin has related the case of a lady afflicted with lumbago who applied flannels dipped in a decoction of smoking tobacco to the ailing part. Her pains were promptly subdued, but she soon felt all the phenomena of intoxication by nicotine, and did not recover from it for three days. Poisoning by tobacco generally occurs by accident or mistake. It is rarely tried criminally, probably because the toxic properties of the drug are not reliable enough. Assassins prefer the alkaloid itself, the effects of which are much more prompt and more terrible than those of the plant. By whatever method it is administered in experiments, the animal is slain. Two drops are enough to kill a large dog; eight drops will kill a horse in four minutes. Under its effects he rages, prances, writhes, falls down, and dies in convulsions. "This alkaloid," says Claude Bernard,* "is one of the most virulent poisons known, and a few drops of it on the cornea of an animal will kill it instantly. Nicotine, apparently sympathetic in its effects, in its action is very much like prussic acid." The action of this principle is so subtle that it can not be analyzed unless the drug is administered in minute doses and very dilute solutions. There is then observed the phenomenon—which goes far to explain the facility with which one is habituated to the use of tobacco—of the rapid development of tolerance of gradually increasing doses. This has been demonstrated by Traube, who, with the twenty-fourth of a drop of nicotine subcutaneously injected, obtained very marked effects on the first day. The next day, on the same animal, it took a whole drop to reach the same result, and at the end of four days five drops were necessary. A similar tolerance is observed in man for hypodermic injections of morphine; but one does not get accustomed to digitaline or strychnine.

When nicotine is administered in doses weak enough to permit an analysis of its effects, almost the same phenomena are witnessed as with the whole plant. In the cases of poisoning already mentioned, there came on at the beginning extreme anguish and agitation, with sensations of burning heat in the pit of the stomach. Respiration was accelerated and the pulse was slackened; then came vomiting and purging, vertigo, and faintness. The face grew pale, the skin was covered with a cold sweat, the head was confused, and the patient fell into a deep stupor, with cries, general trembling, and convulsions. This agitation gives place

* Leçons sur les effets des substances toxiques et médicamenteuses. Paris, 1857, p. 397.

to paralysis and insensibility; respiration is impeded, the pulse declines to a mere thread, and the patient dies in syncope.

When the patient resists the attack, as is most frequently the case, the evolution of the symptoms described above is arrested, and the sufferer comes out of his comatose condition with a violent headache, extreme weakness, and a gastric disturbance which it requires a considerable time to allay.

The effects produced by the habitual use of tobacco differ according to the way it is consumed. They have not been much observed except among smokers, who are most noticed because of their number. Then their habit is open; the smoke goes everywhere, and it causes inconvenience to others; while the more discreet snuff-taker can hide his snuff-box, and annoys with the smell of tobacco only those who come too near him.

Beginners at snuff-taking require, like smokers, an apprenticeship. They begin by sneezing; then the mucous membrane of the nasal fossæ becomes accustomed to the drug, is palled, and even finds itself pleasantly tickled by the ammoniacal piquancy and nicotian perfume of the virulent powder. At last it becomes thick, and with intemperate snuff-takers perceives odors only feebly. It becomes sometimes the seat of a chronic inflammation which extends to the pharynx and produces a slight dry and characteristic cough. Snuff-takers are told of who have suffered from eruptions, ulcerations, and polypi; others have become deaf; but such cases are so rare and their etiology is so doubtful that serious account need not be taken of them.

The only phenomenon peculiar to nicotine often observed among snuff-takers is a rhythmic trembling of the hands, not like that of old men or that of drunkards, but which is observed likewise in excessive smokers. A single case is mentioned by Dr. Bean of *angina pectoris* in a patient who was addicted to an excessive use of snuff. But a solitary case is not important in the consideration of a habit so general, and there is no need of pursuing a fugitive enemy. Snuff-taking is condemned by fashion, from whose decrees there is no appeal. Those of hygiene are not so imperative.

Smoking is charged by its opponents with injuring the health and debasing the mind. The former part of the charge has a measure of foundation. There is certainly nothing hygienic in the habit. All are acquainted with the troubles that ensue on the first effort to smoke. There are nauseas, soon followed by vomiting, headache, vertigo, and a condition resembling sea-sickness, and much like the earlier phenomena of acute poisoning by tobacco. These troubles soon pass away, and after a few succeeding efforts the smoker accustoms himself to the action of the smoke. When the habit is once acquired, smokers feel no further inconvenience; and there are some who are able to smoke just before sitting down at the table. Smoking generally dulls the appetite and gives relief against the pains of hunger. But after eating the desire to smoke becomes irresistible. This is the psychological moment; and the pleasure we feel then is more intense than at any other time in the day. The pipe or the cigar is a condition of good digestion for some smokers, but in others it produces gastric troubles. Nervous people, those who lead a too sedentary life, and office men, especially if they have the habit of smoking before meals, gradually lose their appetite, and acquire instead of it a painful anxiety and nausea. Others suffer from pyrosis. There are smokers who can not light a cigar at some hours in the day without having the feeling of hot iron that marks that affection. Nearly all excessive smokers are dyspeptics; and the fact is explained by the excess of salivation and the diminution of the gastric juice and of the functional energy of the stomach. Next after the digestive troubles, the most common affections touch the respiratory organs and the heart. Granular pharyngitis is very common among persons who smoke to excess. The irritation of the pharynx is often communicated to the larynx, and there results a peculiar dry cough. Others feel a temporary oppression in the evening after having smoked during the day. A special form of asthma has been mentioned as caused by the abuse of tobacco; but cases of it must be very rare, for I have never observed it, though I have passed my life among smokers. Affections of the heart are more frequent. Some doctors assert that one fourth of the smokers are afflicted with palpitations and irregularities of the pulse. I do not know where such observations have been made, but I have never seen any cases of the kind. I, as well as other doctors, have met cases of *angina pectoris*, chiefly among persons who passed their lives in an atmosphere saturated with tobacco, and among those who have swallowed the smoke of their cigars, and have not been surprised at them, because the smoke then enters into the lesser ramifications of the bronchial vessels, where it impresses directly the finest nervous threads of the lungs and the heart, and its action induces the spasms of suffocation that constitute that terrible disease. These symptoms are at first fleeting, and rarely mortal; but, if the patient does not abandon his habit, they occur more frequently, and become more grave till death ensues in one of them. Disasters from breathing an atmosphere saturated with tobacco-smoke seem more liable to occur with children than with grown persons. Staying in smoking-rooms, where the smoke is sometimes so thick that one can hardly see from one end of the room to the other, is dangerous to persons subject to palpitations, even though they do not smoke. Dr. Vallin has cited three facts conclusive as to this point, one of which relates to the case of a young officer who had given up tobacco three months before, and was attacked with a suffocation like *angina pectoris* after having passed several nights in his room where his friends came to smoke for some hours every evening. Dr. Gélineau tells of an epidemic of *angina pectoris* among some sailors who were crowded in the between-decks of a merchant vessel during a storm that made it necessary to close all the hatches, and who smoked to pass away the time. Those who did not join in the smoking suffered equally with the others, for they breathed the same toxic atmosphere.

Pipe-smokers are in danger of epithelioma, or cancer of the lips and of the tongue. The former occurs chiefly among persons who smoke a very short-stemmed clay pipe. Smokers' cancer appears usually at the point where the hot pipe-stem bears upon the lower lip, and on the side of the tongue at the point where the smoke touches at each aspiration. In some cases it begins with buccal *psoriasis*, a kind of thickening of the epithelium of the tongue, which becomes white, glossy, and horny. These two forms of a horrible malady are incontestably the most serious danger smokers incur; and the fear of it is the motive that has impelled the majority of conversions from the habit. The frequency of them should not, however, be exaggerated.

Tobacco has been accused of contributing to the depopulation of the country by enfeebling the reproductive powers of men and inducing miscarriages in women. The former part of the charge is founded on the very real fact that the smoking of tobacco, while its influence prevails, appeases all ardor; but its action is essentially temporary, and does not detract from the general powers of smokers. Their families are as numerous as those of other persons, and the peoples who smoke most are precisely those who have the most children. The Germans smoke twice as much as the French, and have five times as many children. The possibility of tobacco promoting abortions is more open to discussion, but it can not exert any noticeable influence on the movement of population, for it concerns only a very limited class of women—those who work in tobacco-factories. These establishments have borne a bad reputation in the past, and the effect of life in them upon the operatives has been painted in very dark colors. All manufactories were until recently in a deplorable hygienic condition. Now the rooms are spacious and well ventilated, and all precautions are taken to preserve the health of the operatives.

But, whatever may be done, the vapors of nicotine can not be got rid of in the shops where large quantities of tobacco are dried and fermented, or where it is stored in bales and casks. When the leaves are cleaned and mixed, in rasping and grinding, dust as active as the vapors is diffused around. Operatives who work in this atmosphere are in the situation of smokers, and become habituated to it after having suffered the same disorders in the beginning. Those who work in smaller and insufficiently ventilated rooms are often more seriously affected; but, as a rule, these workmen enjoy good health. Opinions as to the particular effect of this employment on women differ; but the prevalent result of the discussion appears to be that tobacco does not provoke abortion, and has no mischievous influence on the health of women operatives. Abortion is not more frequent among them than among other working-women; and the weakness and mortality of their children are easily explained by the fact of their being left at home while their mothers are at the shop.

Among the maladies to which hardened smokers are exposed is nicotinic amblyopia, which Sichel noticed first, and which has been well studied by modern ophthalmologists. It is a peculiar weakening of the sight, and is distinguished from other affections of the kind by the readiness with which it passes away when the patient gives up tobacco, and the promptitude with which it appears again when he resumes the practice. It is very rare. So is a paralysis which has been observed in Germany. Delirium tremens, convulsions, epilepsy, hallucinations, dementia, precocious senility, and melancholia have been mentioned as among the evils brought on by tobacco. No doubt smokers have them, and many other diseases. Tobacco will not save them from any of the ills with which mankind is afflicted.

Of all the accusations that have been made against tobacco, that of blunting the intellect is the most cruel to smokers. But the evidence in favor of it is not formidable. That most frequently encountered is obtained from statistics that show that in institutions for public instruction smokers stand lower in their classes than other pupils. Decaisne has shown this for the French lycées; MM. Bartillon, G. Doré, and Élie Joubert, for the pupils of the Polytechnic School; and Dr. Coustan, for the Normal and Naval Schools and the School of Bridges and Roads. The demonstration is hardly satisfactory. It seems reasonable to assume that the smoking pupils do not succeed so well as the others because they are idle and find in tobacco an auxiliary to their indolence and a relief from its consequent *ennui*. Probably, if the investigation had been pushed further, it would have been found that the same pupils are those whose general conduct leaves most to be desired, and who are most frequently punished. Discussion of this charge brings up an international comparison that is not favorable to its validity. There is a people north of the Rhine, whom I have already mentioned, and with whom the use of tobacco has almost become an institution. They consume a half more than we (the French), and yet we have to admit that these Germans are not as dull as they should be by the theory, that they do not cut a bad figure in the scientific world, and that they hold a preponderant position in Europe. A more specious argument than this is one which the detractors of tobacco draw from the enfeeblement of memory which many observers pretend to have remarked. This would be a serious matter if the charge was sustained; but it does not appear to me proved. Instances have been related in good faith, it is true, of persons who are supposed to have lost their memories through the use of tobacco; but my impression is, that the loss can be more properly attributed to advancing age.

I have no thought of writing an apology for tobacco, or of asking for the erection of a statue of Jean Nicot. Smoking is a bad habit for everybody, especially for women and children. But because tobacco is a grand culprit is a reason why it should not be painted blacker than it is. If we exaggerate its faults and attribute imaginary ones to it, we run the risk of wholly missing our aim. In fact, children whom we are trying to preserve from it, when they see smokers around them able-bodied and sparkling with wit, are disposed to think we are deceiving them when we hold up this bugbear before them, and will come to not believing the real evils of the bad habit against which we are trying to fortify them.

Last to be considered is the philosophical side of the question: What is the motive that impels so many persons to contract an inconvenient, expensive, and unhealthy habit? The problem is insoluble to persons who do not smoke. "I can never comprehend," lately said a professor of hygiene, "the enjoyment one can feel in converting his mouth into a chimney-flue." Dupuytren called the habit of smoking the ignoble pleasure of poisoning one's self and others. This is not surprising; but it is more so that smokers themselves can not account for the fact. The general opinion is, that we begin to smoke to imitate others, and continue it by habit, as a distraction, or means of dispelling *ennui*. "The boy of fourteen or fifteen years, beginning to smoke," says M. Dumas, "does not seek a cerebral excitement in the new habit any more than one who is beginning to drink. He simply imitates the bearded persons whom he sees with the pipe or cigar in their mouths. It is to him one of the signs of the virility to which he aspires. It is the easiest way for him to make himself believe that he is already a man, and to make the public believe it." This is true, but few smokers can find any traces of this feeling in their recollections; but while the desire of affirming one's virility and doing like others may explain the first essays in the face of the pains that attend them, it does not account for the irresistible attraction of the habit once formed and the readiness with which it establishes itself.

The customs and tastes of populations and the fashions change and give place to others that disappear in their turn, after having inspired the same infatuation in us; but the habit of smoking goes on increasing, over all obstacles. The earliest adepts of the practice braved anathemas and persecutions, and some of them punishments. The smokers of to-day do not have to make the same struggles, but many of them endure troubles that compromise their health rather than abandon the practice, and among these are men of energy and intelligence, whatever else may be said of them.

There must, therefore, be in this passion something besides the satisfaction of a mechanical habit. "The particular intoxication caused by tobacco," says M. Dumas, "must have irresistible attractions for an intoxicant of so recent discovery, the initiation into which is so painful, to have overtaken wine, old as the world." The charm of tobacco-intoxication is not easy to explain. It is in the soothing, says M. Fay; it is an anæsthesia that has become necessary, says M. Richet; it is a state of torpor which conduces to revelry, say others. Tolstoi maintains that it is nothing of this kind, but the desire to stifle the voice of conscience; and, confounding tobacco with alcohol and opium, the Russian romancist envelops them both in the same anathema. In explanation of his view he has recourse to a theory known in physiology as that of duality, or human dynamism. During his conscious life, Tolstoi says, man has frequent occasion to recognize in himself two distinct beings: one blind and sensitive, the other enlightened and thinking. The former eats, drinks, rests, sleeps, reproduces, and moves, like a machine wound up for a certain time. The other, the thinking and enlightened, united with the sensitive one, does not act by itself, but only controls and appraises the conduct of the former one, helping it effectively if it approves, and remaining neutral in the contrary case. This spiritual but powerless being plays in human psychology the part of the compass of the ship, of which the other being is the helmsman. The last can follow the directions of the magnetic needle, or he can pay no attention to them; he is even able, when its warnings annoy him, to disarrange his compass. Weak and timorous persons have recourse to the last expedient. They stifle their conscience, and, in order to do so, use alcohol or tobacco.

Count Tolstoi's theory can not be sustained. It has one particularly weak point in the similarity which the author assumes between the effects of tobacco and of alcohol. Not one of the personages whom the translator of his work consulted protested against this confusion, and still it is false and deceitful. The Russian's paradox may be applied, to a certain extent, to drunkenness. We do sometimes get drunk to forget, to stupefy ourselves, and it is a detestable means. Rogues and criminals all do it; they drink often to give themselves heart, murderers especially; while there is not a case known, as M. Aurelian Schole has observed, of a crime committed with pipe or cigar in the mouth. The author himself confesses that he dulled his conscience with tobacco for a long time. It had not, it is true, many reproaches to address to him. Sometimes it reproved him for idleness, or admonished him for a neglect, or a want of punctuality, or an excess of passion in which he had not measured his tone. To quench his remorse he lighted a cigar, and all was forgotten. If tobacco had never committed worse misdeeds, nobody, I believe, would have thought of quarreling with it.

Other modes of voluntary intoxication have the common characteristic of deranging the reason and the moral sense. Hashish produces hallucinations and delirium, and plunges persons into a condition like madness. Opium puts to sleep, and procures for some persons agreeable dreams; but one becomes quickly habituated to it, the doses have to be increased, all the functions flag, and the opium-smoker falls into a condition of inanity, at times interrupted by fits of homicidal furor. Morphinomaniacs do not suffer the same perversion of mind, but they become false, dissimulating, indifferent to all that is foreign to their passion, extending to family feeling and even to honor. Their health is injured more quickly than by opium-smoking, and their life is shortened as much. Alcoholism is still worse. I have studied its effects in all their phases in another work, and will not repeat my conclusions now. It is sufficient to recollect that the ignoble and degrading vice attacks nations in all their vital forces; families in their honor, fortune, and prosperity; that it peoples hospitals, insane asylums, and prisons; and costs France a milliard and a half of francs a year.

Tobacco can be reproached with no such mischief. It has never led the reason astray, destroyed the will, or perverted the sensibility of any one. The most hardened smoker enjoys at all times the most perfect clearness of mind. Even at the moment when he is under the influence of nicotine he talks, reasons, studies, and works with a freedom of thought that proves that his intelligence has not received any harm. One might say that tobacco had disengaged him from physical impressions, and that, as Dr. Richet says, it mollifies the sensibility of the organs only to leave the psychical functions greater freedom of evolution.

There is another characteristic difference between tobacco and other voluntary poisons. A person can break up the habit of using tobacco, while alcoholism and morphinomania are almost incurable. At the end of my long career I can not recollect having witnessed more than two or three cures from alcoholism, and I can not affirm that they would have been permanent if the subjects had been exposed to new temptations. Morphinomaniacs are absolutely incurable unless they are interned. Smokers, on the other hand, can correct themselves when they wish to. They only need a firm will. We see persons every day who have done this; and since the troubles caused by tobacco have been more definitely known we see many men giving it up of their own accord as they advance in age. The habit is so completely lost that after a few years the reformed victim can find himself in a company of smokers without feeling a desire to imitate them; and if he is moved to light a cigar he will not find the pleasure of the old days in it.*

I might stop here; but I will not finish this article without giving my own explanation of the fascination of tobacco. It is probably no better than the others, and I will not try to impose it on any one.

Men have at all times eagerly sought for substances that would act on their nervous system. The tendency is general, and is exclusively human. To escape real life and the drudgery of daily occupations, to live in dream-land, in an ideal world which the imagination can people at its will, and can embellish with its illusions, have irresistible charms to some minds. In obedience to this dangerous seduction they involuntarily seek the dreams of opium and hashish, the intoxication of ether and chloral, or the grosser drunkenness of alcohol. The weak yield unresistingly to their inclination, and pass into the degrading excesses which I have reviewed. Tobacco offers no such seductions and is attended with no such dangers. Its action on the nervous system is weak and wholly special. It does not put to sleep, but it calms and mollifies the sensibility of the organs. It causes an agreeable torpor, during which thought continues lucid, and the capacity for work is not diminished. Such is the attraction it exercises, and which causes it to be sought for by so many thinkers and students. Tobacco is to them a help in mental labor. When fatigue begins and the need of a moment's rest is felt; when the thought fails to present itself with the usual exactness, and the mind hesitates over the shape to give it, the student, writer, or investigator stops, lights his pipe, and soon, by favor of this pleasant narcotic, the thought appears clear and limpid through the bluish cloud in which the smoker has enveloped himself.

I should make a wrong impression if I left it to be believed that I thought tobacco necessary to mental labor. It becomes so only for those who have contracted the habit of using it, and they

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* The translator of this article was an inveterate smoker till the summer of 1868. One evening he said to himself that he would not smoke that evening. That is all the resolution he ever took; but he has never smoked or desired to smoke since.

can divorce themselves from it without losing their capacity. As a whole, tobacco is harmless to the mind, but it may have a mischievous influence on the health, and may cause serious diseases. We should not advise any one to use it, and should try to keep women and children from doing so. In taking up this part of its programme, and in affiliating itself with teachers of all grades, the Society against the Abuse of Tobacco has performed real service; but it has tried to gain its end by exaggerations that can only compromise it. It is of no use, and would be labor lost, to try to convert adult smokers so long as they experience no inconvenience from the habit. As soon as they begin to feel some troubles, and have reached an age when the troubles may become grave, the dangers to which they are exposing themselves should be described to them without extenuating them, but without making the picture blacker. If dangerous affections are threatened, like *angina pectoris*, or injuries to the tongue and lips, a decisive course must be taken, and the immediate and complete abandonment of the cigarette and pipe insisted upon, for experience has taught that there can be no gradual leaving off.—*Translated for The Popular Science Monthly from the Revue des Deux Mondes.*

ODORS AND THE SENSE OF SMELL.

By M. CHARLES HENRY.

A CONSIDERABLE number of mineral compounds are odorous. It is enough to mention, as illustrations of the fact, the sulphureted hydrogen odor of rotten eggs, and the scent of hydrocyanic acid which emanates from bitter almonds. Although perfumes, or pleasant smells, are organic or carbon compounds, the distinction between organic and inorganic may be considered artificial, since the principal organic bodies can be obtained by the combination of such simple mineral elements as carbon, oxygen, hydrogen, and nitrogen. On the gradual complication of syntheses of this kind M. Berthelot, who has made more of them than any other chemist, has based a classification of organic compounds into eight categories. We have first, hydrocarbons, formed of the two elements—acetylene, formene, benzene, turpentine, styrolene, etc. The bodies composed of three elements—carbon, hydrogen, and oxygen—are divided among four categories. We distinguish between the alcohols, which are capable of uniting directly with acids to form ethers with the elimination of the elements of water; the aldehydes, which are formed at the expense of the alcohols, with the loss of hydrogen, among which are the essence of bitter almonds and the essence of cinnamon; the acids, like acetic and benzoic acids, which can unite with bases and form salts; and the ethers, the results of the association of alcohols, acids, or other alcohols, among which are the oils of the onion and of mustard. Among quaternary compounds we have the alkaloids formed by the union of the alcohols with ammonia or other alkalies, amides formed by the union of ammonia and acids with the separation of the elements of water; and the metallic radical compounds which are obtained by the reaction of metals on some of the ethers.

Perfumes are, in general, binary or ternary compounds characterized by the fact that the proportion of equivalents of hydrogen to those of carbon diminishes at the same rate as those of another class of products very rich in hydrogen which are called the fatty series, while this class of products, less rich in hydrogen, is called the aromatic series. Is there any relation between odor and chemical composition? An English physiologist, Mr. John Berry Haycraft, in his studies of the savors and odors, and savors of the principal compounds of each natural family of bodies, particularly of compounds of the family oxygen, sulphur, chromium, selenium, molybdenum, tellurium, didymium, tungsten, and uranium, has observed modifications in odor corresponding with increase in atomic weights. For example, sulphureted hydrogen, hydrogen selenide, and hydrogen telluride smell like rotten eggs. The compounds of elements of this family with methyl and ethyl have an alliaceous odor. So with the family chlorine, bromine, and iodine; the acids which these bodies form with hydrogen and their compounds with methyl, ethyl, and ethylene have similar odors, so that some among them seem to share them with their neighbors; bromoform, for example, having a similar odor with chloroform and iodoform. Passing to the organic series, Mr. Haycraft observes in the monatomic alcohols a modification of odor corresponding with variations in atomic weight. Methyl alcohol, for instance, has a weak odor of alcohol; ethyl alcohol has the typical alcoholic odor; propylic alcohol has both an alcoholic odor and a special smell; isobutylic, amylic, and octylic alcohols progressively lose the alcoholic odor and acquire as against it a special scent. The same facts are remarked in the fatty acids and hydrocarbons.

Similar odors may be furnished by bodies without likeness in chemical composition. Arsenic in oxidizing disengages vapors that have the odor of garlic. Nitrobenzene, benzoic aldehyde, and prussic acid smell much alike. It has been asserted that emeralds pounded and ground several hours a day for three weeks had emitted a well-defined odor of violets. The fact has been verified; but it has yet to be determined whether it is due to the manipulation or to organic substances that have been released by the trituration. Sulphuric acid, combined with distilled water, disengages a pungent odor resembling that of musk. The odor of musk is brought out in a great many reactions. The nitrate derivatives of aromatic substances smell of it; artificial musk and natural musk have no chemical resemblance. So alcohols chemically identical, but of different derivation, do not behave alike with essential oils. As odor is thus in a great measure independent of the chemical constitution, it must depend upon the disposition of the particles, a property which it is evidently impossible to discover by any known chemical processes.

A few eminent chemists, following Dalton, Avogadro, and Ampère, have tried to make up for this impossibility by hypothesis, and have taken up the great problem of predicting and explaining chemical combinations and isomeries. Their theories, called atomic, have been adopted in most of the original memoirs and taught in most of the text-books. Whatever may be their scientific value, the aids they give him in retaining and recollecting the formulas present incontestable advantages to the student. The applications of them to the study of the aromatic series are famous.

The radical of the hydrocarbons of this series and of all the other compounds is benzene, a body composed of six atoms of carbon and six atoms of hydrogen; when it is attacked by a reagent, and we substitute for an atom of hydrogen another simple body or a group of atoms, whichever of the atoms of hydrogen the substitution may bear upon, we obtain a single product; whence it is concluded that each atom of carbon is united to an atom of hydrogen, and that a symmetrical exchange can take place of the atoms of carbon among their valencies. A German chemist, Herr Kekulé, has tried to express these peculiarities by a hexagonal scheme which has still some lack of symmetry, and M. Ladenbourg has substituted a prismatic scheme for it. In this figure the six atoms of carbon of the benzene occupy the summits of a triangular prism, each one being united with an atom of hydrogen and exchanging the three valencies that are left it with the three next atoms of carbon by the three edges which meet at the summit. The perfect symmetry of this scheme is well expressed in the simple construction of the figure. But usually, for greater convenience, the hexagonal construction is adopted, and the reciprocal relations of the atoms of carbon and hydrogen are represented by figures in which the more or less complex lateral chains are joined, and which offer the remarkable characteristic of being closed chains—that is, of always returning to their starting-point. What the atomic theories have taught us concerning odor is limited to this singular and so far unfruitful representation; it is evident that they are still mute concerning the real structure of the molecular edifice. The efforts which have been recently made to fill this void are more difficult to expound and follow than fruitful in applications.

Six methods of extracting perfumes are known: The first is expression, by means of a special press, which is applicable without too great loss to fruit-skins rich in essential oils, such as orange and citron peel, previously grated. Another method is that of distillation, which consists in heating flowers with water in a boiler. The essential oil is volatilized and is condensed with the vapor of water in a worm and a Florentine receiver. The water usually goes to the bottom and the oil floats. The oils of neroli, rose, patchouli, geranium, lavender, caraway, etc., are obtained in this way. This process is not applicable to the delicate perfumes of the mignonette and the violet; and for them recourse is had to maceration of the flowers in animal fats or mineral oils, which have the property of absorbing odorous substances, and are then washed in alcohol. The flowers are usually heated in the fat or the oil for a variable number of hours. For perfumes which can not endure a high temperature the petals are placed between two frames of glass coated with fat. This is the process of *enfleurage*. The pneumatic process, which consists in causing a current of perfumed air or carbonic acid to be absorbed by coatings of lard on glass plates, appears not to have given satisfactory results. Another process consists in dissolving perfumes in very volatile liquids like sulphuret of carbon, chloroform, naphtha, ether, or chloride of methyl, and volatilizing the solvents, which can be done at a low temperature in a vacuum. The last method has given very satisfactory results in the extreme delicacy and great accuracy of its returns.

Series.	Types.	Secondary odors of the same series.
Rose	The rose	Geranium, eglantine, palissander.
Jasmin	The jasmin	Lily of the valley, ylang-ylang.
Orange	Orange flower, or neroli	Acacia, syringa, orange leaf.
Tuberose	Tuberose	Lily, jonquil, narcissus, hyacinth.
Violaceous	Violet	Cassis, iris, mignonette.
Balsamic	Vanilla	Balsams of Peru and Tolu, benzoin, storax, tonka bean, heliotrope.
Spicy	Cinnamon	Nutmeg, mace, allspice.
Caryophyllaceous	Clove	Pink.
Camphor	Camphor	Rosemary, patchouli.
Sandal	Sandal-wood	Vetivert, cedar.
Citrine	Citron	Orange, bergamot, cedrat, lime fruit.
Herbaceous	Lavender	Aspic, thyme, wild thyme, marjoram.
Mint	Peppermint	Wild mint, basil, sage.
Anise	Anise	Anise-seed, caraway, dill, fennel, coriander.
Almond	Bitter almonds	Laurel, nut, mirbane.
Musky	Musk	Civet, musk-mallows.
Amber	Ambergris.	
Fruit	Pear	Apple, pineapple, quince.

Numerous classifications of odors have been proposed. It is, of course, impossible to quote any rational classification. The natural way is to group around a type, in successive series, odors which resemble one another. Eugène Rimmer has tried to do this in the accompanying table.

The author observes that it would be hard to arrange in any of these series certain peculiar odors like that of wintergreen, or salicylate of methyl and magnolia. Notwithstanding the uncertainties attending the arrangement, we must apparently depend upon classifications based upon this principle for a guide in the study of odors.

All that we know concerning the propagation of an odor is that it consists in an emission of solid, liquid, or gaseous particles. This emission is allied for these three states of matter to the property called diffusion, which consists in the reciprocal penetration at the end of a certain time of the particles of two or more bodies among one another; and also for solids and liquids to the property called volatility, or the rapidity of evaporation.

But little is known concerning the diffusion of solids. If we heat to a high temperature a porcelain crucible within a crucible of plumbago, the plumbago will penetrate the porcelain to a depth varying according to the duration of the experiment. M. Pellat has shown, by delicate measures of quantities of electricity, that metallic surfaces placed parallel to one another a few tenths of a millimetre apart, reciprocally exchange their outer surfaces, as if they emitted a little of their own substance to each other. When the influence ceases, the surfaces gradually lose their foreign coatings, and return slowly to their primary condition.

The diffusion of liquids is easily observed. It can be witnessed by introducing, with a pipette, into a vessel under water a colored liquid, red wine, for example. The wine, being lighter than water, rises to the surface, and does not color the deeper layers of the water till after one or two days. There is doubtless in the complicated diffusion of liquids a kind of chemical action related to the movements on water of camphor and a considerable number of diffusible substances. If we put a bit of camphor on the surface of water, it at once turns round and moves in every direction. If a drop of oil is let fall on the same surface, the movements will cease immediately. The motion arises from the diffusion of camphor in a liquid form on the surface of water. When, after the surface is saturated, there is no more diffusion, the motions cease. They also cease when two currents are produced by different bodies in opposite directions. That there is a liquid diffusion is proved by the fact that when the camphor is placed on a float of pith, or on the polished surface of mercury, there is no movement. So, if a bit of camphor is put into a large saucer covered with a thin layer of water, the water immediately retires, sometimes for several centimetres, before the odorous substance. The laws of the diffusion of liquids may be summarized by saying that the rapidity depends on the nature of the substance, increases in proportion to the degree of concentration of the solution, and augments as the temperature rises. Graham's dialyzer is based on the very feeble diffusibility of certain substances, like the gums, and the great diffusibility of certain crystalline substances, like salt. It is simply a vessel, the bottom of which is formed of a leaf of parchment paper, that lets the diffusible substances pass into the water around it and holds the others.

The diffusion of gases and vapors, which is more important in questions of smell, is subject to laws which have been only approximately determined. A glass tube about a metre long is used, divided perpendicularly to its length by a thin metallic partition, which can be made to slide between two perforated glasses. A gas is introduced into each of the separated halves of the tube; the supply-cocks are closed, the partition is lifted out, and the two halves of the tube are put in communication; a half-hour later the partition is shut, and the gaseous mixture contained in each of the compartments is analyzed. Mr. Loschmidt has in this way found the mathematical rule for the measure of the diffusion of different gases, one within the other.

The volatility of a liquid is expressed by the weight of that liquid which evaporates per second and per square millimetre at a given temperature. All that is known of it is that this weight is proportioned to the excess of the maximum tension of the vapor at that temperature over the tension which it has in the air; and this weight varies inversely as the atmospheric pressure according to a law special for each liquid. Evaporation may, therefore, give us valuable information concerning the purity of the odor, and spare us, in many cases, the delicate problem of determining the maximum tension which is so important a characteristic of substances. A special apparatus has been devised for the rapid measurement of volatility.

Tables have been prepared showing the relative volatility of different perfumes, of the substances used for adulterating them, and of the adulterations, by means of which a convenient method is afforded for the detection of frauds.

The influence of different physical forces on the disengagement of odor has been studied; and possible relations between the colors of flowers and the intensity of their perfumes have been inquired into. It has been found that white flowers represent the largest number of odoriferous species, and after them come red, yellow, green, and blue. The order corresponds with that of the emission of calorific force. Flowers which by their color emit the most heat, also emit the most perfume.

The results of the study of the influence of the color of substances on their power of absorbing odors differ a little from these: white, yellow, red, green, and blue absorb odors in a decreasing order, or rather emit them in an increasing one. These colors represent decreasing luminous powers.

Ozone develops the energy of essential oils, and perfumes in turn determine by their oxidation in the air the production of ozone. This is a matter of hygienic significance, for the presence of ozone being favorable to health, we have a means at hand of increasing the supply of it by surrounding ourselves with fragrant substances and flowers.

Heat favors the volatilization of perfumes, and to such an extent that beds of flowers are sometimes inodorous in the bright sunlight which are fragrant in the shade. Some essences need a high temperature for the production of their full effect; while others, to have their delicacy fully appreciated, require the coolness of the evening. This principle may account for apparent differences of tastes among the people of different countries. The odors of many substances are not of equal strength in different climates. Prof. Tyndall believes that there are considerable differences in the absorbing power of different odorous vapors for radiant heat. He perfumed small paper cylinders by dipping them by one end in an aromatic oil, and then placed them in a glass tube, which communicated, through a stop-cock, with a tube in which a vacuum is produced. The air, according as it has been perfumed with one substance or another, discloses to the galvanometer an absorbing power, which, air at the usual pressure being taken as one, varies from thirty for patchouli, to three hundred and seventy-two for anise-seed. These results are, unfortunately, not exact, for no account is taken in them of the tensions of the odorous vapors, which certainly vary, though they are probably of very small absolute value.

Messrs. Nichols and Bailey have compared the smelling powers of men and women. Having made measured solutions of a number of essential oils, a series of flasks was prepared so that the solution in each succeeding one should be only half as strong as that in the preceding one. The flasks were "shuffled," and the subjects of the experiment were called upon to rearrange them in the order of concentration of the solutions. The smelling power of women appeared to be on the whole less delicate than that of the men. The extreme delicacy of the scent of the dog is well known. Mr. Romanes has shown that, by fastening a sheet of paper to the shoes, the odor may be masked, and the dog prevented from following the track of his master; but that a contact with the ground of a few square millimetres is enough to enable the dog to follow the scent. In birds, the sense of smell appears to be little developed; in mollusks and insects the smelling apparatus has been located in the antennæ. Below the group of worms, no olfactory reactions have been, so far as I know, definitely established.

The mechanism of the olfactory apparatus is, as a whole, simpler than that of sight and hearing; but the sensation is subordinated to many individual anatomical peculiarities. As much can be said of touch and taste, which require contact of the excitant, while sight and hearing merely register the vibrations transmitted by a medium. It is easy to conceive how the condition of the membranes, the form of the nasal passages, etc., may affect the sensation.

A distinction is made in medicine between respiratory anosmias which depend on the formation of the organs and the condition of the connective tissues, and essential anosmias which result from atrophy of the nerves. Anosmias are frequent; some are congenital, many are senile and temporary, and connected with traumatisms, hemianæsthesia, aphasia, and hemiplegia. We can not expect to find as concordant reactions for the smell as for the sense of color or the sense of form. It is nevertheless a matter of interest to investigate, on as good subjects as we can get, the influence of different odors on sensibility; or, in other words, to determine the weight of odorous vapor which it is necessary to breathe and accumulate in the nasal fossæ to make a perfume perceptible. That is the purpose of olfactometers. The olfactometer gives, besides this, the intensity of a perfume. The larger the perceptible minimum of a perfume, the less intense the perfume is, and it is this intensity which determines the price of a perfume, the delicacy of its odor being the same.

The olfactory sense is followed by effects of different kinds of intensity from those of sight and hearing, and may be accompanied by a kind of poisoning. The old medical books are full of stories of it. There are those of a girl killed by the exhalations of violets; of a woman seized with a violent headache from sleeping on a bed of roses; and of a girl who lost her voice by smelling of a bouquet. Ancient medicine attributed curative properties to perfumes, particularly to those of the rose, musk, and benzoin. The intensity of the effects of perfumes makes a rapid succession of sensations almost impossible; for consecutive odors cause a rapid anæsthesia of the sense; on the other hand, if the times separating two successive sensations are too long, it becomes impossible to combine them, and the anticipated effect is disturbed by strange feelings. In short, smell is rather the complement of other excitations than an artistic excitation like a melody or a picture. Its function is, nevertheless, very important. By virtue of its volatility it is a valuable prophylactic; by the great intensity of its effects it can bring about salutary modifications of physiological functions, particularly of the amplitude of respiration; and it possesses in the highest degree the luxurious character of every artistic enjoyment. Flavor has an essential part in nutrition; so has touch. Hearing and sight are indispensable to relations with other persons; but smell, necessary to the animal for finding its prey and avoiding danger, has become, under normal conditions, an almost useless sense to man, since the refinements of civilization tend to prevent the production of miasms and the pestilential odors from which he has to protect himself. It is therefore becoming more and more a sense of luxury for civilized man; and that, perhaps, is the reason why poets, from the author of the Song of Songs down, have associated all kinds of beauty and joy with perfumes.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

CHANGES IN CHEMICAL AND GEOGRAPHICAL WORDS.

By FREDERIK A. FERNALD.

"HOW do you pronounce *quinine?*" is a question that is often asked, and, unless the person appealed to is unusually dogmatic, the answer is never decisive. Webster's International Dictionary gives three forms as being in good use—namely, *kwī'nīn, kwĭ'nīn,* and *kwĭ'nēn;* the Century Dictionary gives two of these and a fourth form, *kwĭn'ēn, kĭnēn',* and *kwī'nīn;* while a fifth variant is found in Stormonth, which has only *kwĭn'īn* and *kwĭnīn'.* Physicians and chemists, from having to use this word oftener than the general public, have been more annoyed by the conflicting pronunciations. Other words that have troubled the chemists are the names of the halogens, some pronouncing them *chlō'rīn, brō'mīn, ī'ōdīn,* and *flū'ōrīn,* while others said *chlō'rēn,* etc. A more serious difficulty is the liability to mistake certain substances for others, from the close likeness of whole classes of names, both when spoken and when written. This occurs with the *chlorīdes* and the *chlorītes,* also with the *sulphīdes* and the *sulphītes.* In order to do away with these difficulties, a proposition for a revision of the spelling and pronunciation of chemical terms was made in the Chemical Section of the American Association for the Advancement of Science, at the annual meeting in 1887. Accordingly, a committee to make such a revision was appointed, and made its final report at the meeting of 1891. This report says:

During the past four years, your committee has sought to obtain from the members of this section, from leading American philologists, and from American chemists in general, an exhaustive and thoroughly representative expression of opinion on the questions coming within the scope of its commission, which has been essentially the attainment of uniformity in the orthography and pronunciation of the terms used in our science.

Three preliminary reports were distributed to American chemists in the years 1889, 1890, and 1891, inviting extended criticism and suggestion. The substance of the replies to these was carefully digested and submitted to the Chemical Section each year for detailed discussion and decision. The present and final report of your committee embodies the results of these four years of correspondence and discussion, as completed by the sectional action at the present meeting of the Association. It is presented in the hope that all chemists, especially those engaged in teaching, will cordially unite in the effort to bring about the desired uniformity in usage.

The reasons for the adoption of a few more radical changes in our nomenclature are to be found in the report for 1890. Those specially interested in the subject who have not attended the recent sessions of the Association may freely correspond with individual members of the committee, who will gladly furnish more detailed explanation of the principles involved.

The following summary of rules is not to be regarded as final. Your committee recognize the fact that, after a fair trial for a decade or even less, certain modifications will in all probability be generally regarded as desirable.

In conclusion, the committee express their sincere thanks to their many colleagues throughout the land, who have so promptly and fully responded to the successive requests for data, suggestions, and opinions.

(Signed) T. H. Norton,
Edward Hart,
H. Carrington Bolton,
James Lewis Howe.

Among the decisions of the committee (all being accepted by the Chemical Section) is to sound the *i* short in the names of the halogens, and the spelling is changed by dropping the final *e*, so as better to indicate this pronunciation: thus, *chlorin*, *bromin*, etc. The "pentalemma" of *quinine* is conquered by adopting a sixth pronunciation *kwĭ'nĭn* and the final *e* is dropped, making the spelling *quinin*. Similar treatment is accorded to *anilin*, *morphin*, *glycerin*, *cocain*, etc. The similarity between *-ide* and *-ite* is removed by changing the former to *-ĭd*, giving *chlorid*, *bromid*, *oxid*, etc.

Polysyllables in the metric system are regarded as compound words, each part with its own accent; thus, not *centi'meter*, but *cen'time"ter*. The spellings *aluminum* and *asbestos* displace *aluminium* and *asbestus*; *gramme* is preferred to *gram* (probably to avoid confusion with *grain* in indistinct handwriting); *al'kalīne* retains the long *i* and its final *e*; *al'loy*, both as noun and as verb, is accented on the first syllable; and *apparā'tus* does duty in both the singular and the plural numbers. *Quan'tiva"lence, ū'niva"lent,* etc., have both a primary and a secondary accent, as has *no'men-cla"ture.* A few more preferred pronunciations are *con'centra"ted, mŏl'ecule, mŏlĕc'ular,* and *ăldehȳde*; both *crystallĭn* and *crystallīne* are accepted. Probably the boldest change in spelling is the substitution of *f* for *ph* in *sulfur* and all its derivatives. *Phosphorus,* however, remains unchanged.

Where two or more names are in use for the same thing, the chemists have given a preference to one of them. Thus, they advise the use of *caffein* rather than *thein, hydrogen sulfid* rather than *sulfuretted hydrogen, valence* rather than *quantivalence,* and *univalent, bivalent,* etc., rather than *monovalent, divalent,* etc.

A large number of other decisions have been rendered, but the foregoing are all that affect words that are in general use, or much used by teachers. The changes which the chemists have decided on are far from being radical. They are all plainly dictated by common sense, and it is to be hoped and expected that they speedily will become the prevailing usage.

Geographical names are also undergoing a revision both here and abroad. There has been heretofore a most perplexing diversity in the spelling of many of them. Names of places in Asia or northern Africa, which are written by their inhabitants in Arabic or some other Eastern language, must be transliterated when they appear in the Roman alphabet. English-speaking geographers would transliterate these names after the analogies of their own language, French geographers would follow the different usage of their language, and the Germans would do likewise. If any language admitted an alternative way of spelling, some author would be sure to adopt it; so that, in the case of an important town in Syria (Beirut), no less than twelve ways of spelling its name have arisen among Western peoples.

Then there were names of places, rivers, etc., in the unwritten native languages of Africa, the Pacific islands, and America, concerning which the same diversity has prevailed. Sometimes a strange spelling has had the force to bring in a mispronunciation. The early English explorers found a nation of Indians in eastern North America whose name they spelled *Algonkin.* The French explorers, having no *k* in their language, and being accustomed to represent the *k*-sound by *qu,* spelled the same name *Algonquin.* Both spellings persist to this day, and many among us, the descendants of the Englishmen, having become acquainted with the form *Algonquin* through the eye and not through the ear, have given the *qu* its English value in pronouncing the word, and say wrongly, "*Algonkwin.*"

In 1885 the Council of the Royal Geographical Society of England began a movement in behalf of systematic spelling in geographical names, which has yielded most gratifying results. The society adopted a system having the same basis that is employed for all scientific modes of spelling, namely, vowels pronounced as in Italian (or German), and consonants as in English. This system has been adopted by the British Admiralty Office, by the War, Foreign, and Colonial Offices, and by the last has been recommended to the colonies.

In September, 1890, the United States Board on Geographic Names was created by order of the President of the United States, for the purpose of securing uniformity of geographical nomenclature in Government publications.

The board consists of ten officials in the departments at Washington, with Prof. Thomas C. Mendenhall, Superintendent of the United States Coast and Geodetic Survey, as chairman. For spelling names from Oriental or unwritten languages, this board has adopted a system practically identical with that used by the British Government offices. Since France, Germany, and Spain have adopted methods substantially the same as this, the great map-making nations of the world are now in close agreement as to geographical spelling. The alphabet is used as follows by the board in representing the sounds of Oriental and unwritten languages: *a* as in f*a*ther (Java, Somáli), *e* as in m*e*n (Tel el Kebír), *i* as in rav*i*ne (Fiji), *o* as in m*o*te, and *u* as *oo* in b*oo*t. All vowels are shortened in sound when the following consonant is doubled. (Yarra, Jidda). Doubling a vowel is necessary only where there is a distinct repetition of its sound. English *i* in *i*ce is represented by *ai* (Shanghai), *au* represents *ow* in h*ow* (Fuchau), *ao* is slightly different from *au* (Nanao), and *ei* is scarcely to be distinguished from *ey* in th*ey* (Beirút).

Among the consonants, *b, d, l, m, n, p, r, s, t, v, w, x,* and *z* are the same as in English; *c* is always soft (Celebes), *ch* as in *ch*ur*ch* (Chingchin), *f* as in English, and its sound is never represented by *ph* (Haifong), *g* is always hard, *h* is always pronounced when inserted, *j* as in English, and its sound is never represented by *dj* (Jinchuen), *k* as in English, and always takes the place of hard *c* (Korea), *kh* stands for the Oriental guttural (Khan), *gh* is another guttural as in the Turkish (Dagh, Ghazi), *ng* as in fi*ng*er, also as in si*ng*er, *q* is not used, *qu* being replaced by *kw* (Kwangtung), *y* is always a consonant and is to be replaced by *i* wherever it has been used as a vowel (Mikindani). Accents should not generally be used, but where there is a very decided emphatic syllable or stress which affects the sound of the word it should be marked by an acute accent (Galápagos, Saráwak).

With regard to names in the United States the policy of the board is to make no changes unless a decided improvement can be secured thereby. Its first principle is that the spelling and pronunciation which are sanctioned by local usage should be adopted in general. Even where the present name is a changed or corrupted one, if it has become firmly established the board keeps its hands off. But where a choice is offered between two or more names for the same locality, all sanctioned by local usage, the opportunity to secure the most appropriate and euphonious one is improved. The possessive form of names is discarded wherever practicable, sometimes by dropping both the (') and the *s*, for instance changing *Gedney's* to *Gedney* Channel, in New York Harbor, and in cases where so much change has not seemed advisable, simply omitting the ('). By the latter procedure, which is practically changing to the plural form, *Minot's Ledge*, in Boston Harbor, becomes *Minots Ledge*. The final *h* is dropped from names ending in *-burgh*, and the ending *-borough* is shortened to *boro*. The spelling *center* is always used rather than *centre*. The board discourages the use of diacritic marks over letters, and hyphens between parts of names; where a name consists of more than one word it prefers to combine the parts into one. The use of the words *City*, *Town*, and *Court House* (abbreviated *C. H.*) as parts of place-names is deemed undesirable.

The first report of the board has been issued recently and contains a list of decisions made during the year which it covers. More than two thousand questions have been submitted to the board, and decisions have been given upon nearly all of them. Early in the year it was called upon to decide concerning several hundred names in Alaska, where the utmost confusion exists concerning geographic nomenclature. To the difficulty of transliterating Russian and Indian words into English letters is added the confusion caused by the fact that expedition after expedition, exploring this region, has assigned new names to the geographic features of the country, ignoring those already given. This state of affairs has induced the board to undertake a complete revision of Alaskan names, the result of which will be a geographical dictionary of the Territory. One of the three bulletins issued during the year contained a list of between five and six hundred decisions rendered at the instance of the Lighthouse Board, and fully a thousand questions were answered for the Census Office. The names of all the counties in the United States have been passed upon, and the approved list appears in the report.

Among the United States names that have been revised are: *Bering* (Sea and Strait), in place of *Behring*, the *h* being a German addition to the original Danish name: *Fort Monroe*, this, not *Fortress Monroe*, being the name given to the works at Old Point Comfort by the Secretary of War in 1828; *Pedee*, for the river formerly called *Great Pedee; Pittsburg* (Pa.), without final *h*, this being really the official form of the city's name; *Mohave* instead of the Spanish form *Mojave*, and *Blackwells Island* in place of *Blackwell's*. *Wood's Holl*, the meaningless corruption of *Wood's Hole* effected by finical summer visitors, is not meddled with except to drop the apostrophe.

Among foreign names *Colon* has been adopted, to the exclusion of *Aspinwall*, *Bermuda* instead of *The Bermudas*, and *Salvador* (Central America) for *San Salvador*. The spelling *Fiji* is preferred to the now antiquated *Feejee; Baluchistan* has been adopted for *Beloochistan;* and a few other accepted spellings are *Kaffraria*, *Chile*, *Haiti*, *Kamerun* (Cameroon), *Kashmir*, *Kongo*, *Puerto Rico*, *Sind* (Sindh), and *Tokyo*.

The accepted forms are used by the Coast and Geodetic Survey, on its charts of the coasts of the United States; the Hydrographic Office of the Navy Department, on the charts of foreign coasts that it publishes; the Geological Survey, which is making a mother-map of the United States; the General Land Office, which compiles from its plats maps of most of the States and Territories; and the Post-Office Department, which decides the names of all post-offices. They are used more or less also by nearly every other bureau of the General Government—in fact, wherever geographical names occur in all printing done at the Government printing-office.

The new forms are also coming into use rapidly among publishers of books and newspapers and the general public. The American Book Company, which furnishes the greater portion of the school-books used in this country, has adopted the decisions of the board for all its text-books on geography. Publishers of atlases and other geographical works generally are using them, so that in a few years it will be easy to tell that a map is old from the fact that the old forms of names are engraved on it. Many newspapers also, that have received copies of the first report of the board, have stated that they should follow it.

The good work of the chemists and geographers in the interest of simplicity and uniformity gives hope that similar changes may be made in other classes of words. Medical terms might come next. Few persons would be sorry to see the *æ* and *œ* replaced by *e* and the silent consonants omitted in "hæmor*rh*age," "gynæcology," "œsophagus," "diar*rh*œa," "*ph*t*h*isis," "*p*neumonia," "r*h*eumatism," "*p*tyalism," "*p*sora," etc. There is a growing tendency toward such simplifications on all sides, and the direct efforts that are being made in this direction are only furthering the progress of a natural evolution. It has been said that we ought to wait for these changes until the natural process makes them; but if men want to put city streets and blocks where there is a hill, they do not wait for geological agencies to level the hill. They go at it with steam-shovels, drills, and dynamite. Another objection that is made to all simplifications of spelling is that they remove the marks of derivation in words. In many cases this is untrue; in the others it is of no consequence. The Italian sees the Greek φωτός and γράφειν just as plainly in his *fotografia* as the Anglo-Saxon does in his *photograph*. As for the marks of derivation from Old French, the Teutonic languages, Arabic, etc., the majority of persons do not see them at all, and those who do and can interpret them are above the need of such aids. It is with words very much as with men. The influence of heredity makes it instructive to know the character of a man's parents and grandparents, but men do not go to business every day carrying charts on which their family trees are delineated. So with words; in every-day use only their present values concern us, and their histories should be left to the dictionaries as family trees are left to genealogical records.

A general simplification of English spelling promises to be one of the events of the near future. Articles in favor of it are appearing with increasing frequency in our leading magazines, the latest being by Brander Matthews, in Harpers' Magazine for July. The philologists as a body desire the change, and there is not one linguistic scholar of any prominence who opposes it. When publishing firms nowadays select editors to make or revise our leading dictionaries, they get spelling reformers, for all the men competent to do such work are of this class. The late President Porter, who edited the International Webster, has expressed himself in favor of simplification; Prof. W. D. Whitney, editor-in-chief, and several of the other editors of the Century Dictionary, are active workers for this reform; Prof. F. A. March, who is in charge of the departments of spelling and pronunciation in the forthcoming Standard Dictionary, is President of the Spelling Reform Association, and many of the collaborators on this work believe in logical spelling. In England, Dr. James A. H. Murray, editor-in-chief of the Philological Society's Dictionary, the greatest lexicographic work on the English language ever undertaken, is an unhesitating advocate of orthographic reform, as is Prof. Walter W. Skeat, author of the Etymological Dictionary. If English spelling were to be made phonetic next year, or in 1900, a few persons might cry, "Give us back our silent letters," as the mob cried, "Give us back our eleven days," when the calendar was changed from old style to new; but only a few months would pass before all would be asking, "Why was this not done generations ago?"

CORRESPONDENCE.

PROPER DIET FOR HOT WEATHER.

Editor Popular Science Monthly.

THE article under the above title in your July number appears to be based on chemical theories of nutrition that find no place in the modern science of physiology. The classification of food constituents into proteids or albuminoids, fats, and carbohydrates is a convenient one for certain purposes, but it is now known that these groups of nutrients have not the specific functions that were formerly attributed to them.

The assumption of Dr. Davies (page 366) that "the foods that are converted into heat—that is, keep up the heat of the body—are starches, sugar, and fat, and those that more particularly nourish the nervous and muscular system are the albumen and salts," is a survival of an obsolete theory of respiration; and tables giving the proximate composition of different articles of food are of little value in formulating diets for special purposes.

The law of the conservation of energy is now recognized as a significant factor in all physiological processes, and it furnishes the only consistent explanation of the phenomena of animal heat. The energy used in the constructive processes is stored up as potential energy, as an essential condition or constituent of all organic substances, and on their disintegration in the processes of destructive metabolism it is liberated in the form of heat—as in the digestion of foods, and in the wear and tear of the tissues that are constantly taking place in all vital activities.

Animal heat is not produced by a combustion of certain food constituents that serve as fuel, but it is the result of the liberation of the stored energy of foods and tissues, in the disintegrating processes they undergo in the system. Dr. M. Foster, who is recognized as one of the best authorities in physiology, estimates the potential energy of food constituents as follows:

1 gramme	proteids	= 4,500 calories,
1 "	fat	= 9,000 "
1 "	carbohydrates	= 4,000 "

From this it appears that the "starches and sugars," which are included in the group of carbohydrates, contain less potential energy than the proteids, and the heat obtained from them is accordingly less. The inference that starch and sugar should be avoided in hot weather, and largely replaced by lean meat, which consists in the main of proteids or albuminoids, is, therefore, not warranted by the evidence in regard to their constitution.

Without noticing the numerous fallacies in the article in question, attention is called to the widely different conclusions reached by Dr. Foster, in the last edition of his Physiology, in discussing the adaptations of diets to climatic conditions, and to the requirements of the system in brain-work and severe muscular labor.

He says: "With regard to climate the chief considerations attach to temperature. When the body is exposed to a low temperature, the general metabolism of the body is increased, owing to a regulative action of the nervous system. We might infer from this that more food is necessary in cold climates; and, since the increase in the metabolism appears to manifest itself chiefly in a greater discharge of carbonic acid, and therefore to be especially a carbon metabolism, we might infer that the carbon elements of food should be especially increased. When the body is exposed to high temperatures the same reflex mechanism tends to lower the metabolism; but the effects in this direction are much less clear than those of cold, and soon reach their limits; the bodily temperature is maintained constant under the influence of surrounding warmth *not so much by diminished production as by increased loss.* We may infer from this that in warm climates not less, but if anything, rather more food than in temperate climates is necessary in order to supply the perspiration needed for the *greater evaporation and discharge of heat by the skin.* . . . Indeed, the evidence that the increase of metabolism provoked by cold bears exclusively on carbon constituents, is so uncertain that it may be doubted whether any change in the normal diet, beyond some increase in the whole, should be made to meet a cold climate. Similar reasons would lead one to infer that man in the warmer climate would maintain on the whole the same normal diet, *the only change perhaps being to increase it slightly, possibly throwing the increase chiefly on the carbohydrates* with *the special view* of *furthering* perspiration. . . .

"In choosing a diet for muscular labor we must have in view *not the muscle itself, but the whole organism.* And although it is possible that future research may suggest minor changes in the various components of a normal diet, such as would lessen the strain during labor on this or that part of the body, on the muscles as well as on other organs, our present knowledge would rather lead us to conclude that what is good for the organism in comparative rest is good also for the organism in arduous work; that the diet, normal for the former condition, would need for the latter a limited total increase, but no striking change in its composition. . . . The principles of such a conclusion with regard to muscular work may be applied with still greater confidence to nervous or mental work. The actual expenditure of energy in nervous work is relatively small, but the indirect influence on the economy is very great. The closeness and intricacies of the ties which bind all parts of the body together are very clearly shown by the well-known tendency of so-called brain-work to derange the digestive and metabolic activities of the body; and *if there be any diet especially suited for intellectual labor, it is one directed not in any way toward the brain, but entirely toward lightening the labors of and smoothing the way for such parts of the body as the stomach and the liver.*"

It is evident from these statements that our present knowledge of the physiology of nutrition does not warrant any prescriptions of special food constituents for the assumed varying requirements of the system under different climatic conditions or for different kinds of work.

Individual peculiarities and inherited habits of the system are prominent factors in the processes of nutrition, and experience is a safer guide in regulating one's diet than any theories based on the chemical composition of foods. Yours truly,

MANLY MILES.

LANSING, MICH.

THE PROTECTION OF BRAKEMEN.

Editor Popular Science Monthly:

SIR: By the omission of a line in printing the note I made to my suggestion as to the protection of brakemen against mutilation by accidents in coupling freight-cars (which escaped me in the proof), my suggestion itself loses whatever force it might have, I think, by being too exemplary. My suggestion was (page 222 of The Popular Science Monthly for June, 1892) that a statute might be provided requiring the draw-heads of all freight-cars manufactured or admitted into the United States to be of a uniform height and to be within projecting frame corners from the rail surface, everybody can see that not only humanity but perfect justice both to the railway company and to the employé would be subserved.

The note I added should read as follows: I think such a law as this would be a better one than one directing the use of an automatic coupler, for it would not throw any brakemen out of their jobs. As to the loss of life spoken of by the President, the larger number of instances will, I think, be found to have occurred at night, when brakemen, not knowing of course the height of the draw-heads of the cars approaching them, and often while using every precaution, might be caught and crushed by a different build of car with flush corners, or higher or lower timbered corners. Such a law, prescribing uniformity in this detail, and mulcting the company owning the car or cars causing the death or mutilation, by reason of its willful omission to observe the provisions of that law, with adequate damages, would be, I think, a salutary and an exemplary one.

Since the matter is one which certainly calls for attention, I should be glad if you would insert this letter in your next issue.

Yours, etc.,

APPLETON MORGAN.

NEW YORK, *June* 1, 1892.

EDITOR'S TABLE.

POLITICAL PROGRESS.

WHEN we look back over the history of this country since the close of the civil war we find, on the whole, ample cause for satisfaction and encouragement. Those who look for perfection in the working of political institutions are doomed to disappointment. Happy is the nation that, as the years and decades slip by, can count some solid gains for the cause of good government and national morality, even though many parts of the political machine may work faultily, and many evil tendencies manifest themselves from time to time. After the war, we entered upon a period of almost shameless political corruption, not only in national but in State and municipal affairs as well. To say that we have completely thrown off the disease of corruption would be, we fear, to say too much; but that a very considerable purification has been effected, especially in connection with the national Government, no one can doubt. Too many individuals throughout the community are indeed indifferent to this evil, and many are ready to make all kinds of apologies for it, as something that can not be dispensed with in connection with popular institutions; but in some way or other the nation, as a whole, has set its face against it, and the suspicion of being systematically corrupt—that is to say, of practicing, or being prepared to practice, corruption in the administration of the national Government—would be fatal to either political party.

Twenty years ago the "spoils system" was in full force. Every office under the Government was virtually used for purposes of bribery. It was bestowed in the first place as a reward for fidelity to party, and the salary attached to it was afterward assessed for contributions to the party funds. The sense of decency of the people has risen up in revolt against this abomination, and, though the principles of civil-service reform have not yet been carried far enough, the great body of the national civil service has been placed on an independent and honorable footing. No party manager can now fry the meager "fat" out of the smaller office-holders for political purposes; the only persons to whom that process can at present be applied are the higher functionaries and the protected manufacturers. The result of this partial yet extensive reform of the civil service has been a considerable increase in the efficiency of the public departments. The public interest is now kept in view where formerly there was little thought of anything save how to make an office temporarily held of as much advantage as possible to the holder. The effect on the self-respect of the service is already marked, and we can not doubt that it will become more so as years go on.

But there is further progress yet to be made. The perfection of any machine is to consist of the fewest parts—in other words, to be as simple as possible in construction—and to accomplish its work with the least possible loss of energy. In judging of our political and administrative institutions we can not keep this analogy too closely in view. But here arises a prior question: What is the work which our political machine should be set to accomplish? Is it, for example, to regulate the whole industrial and commercial life of the people? If so, adieu all hope of simplicity of construction! Adieu, we may add, all hope of any efficient performance of so huge, so unlimited a task. As has often been pointed out—more than once in these columns—the system of taking certain industries under the protection and patronage of the state is, in itself, a species of corruption, and has its natural result in special acts of gross corruption. What will a wealthy manufacturer, whose profits depend in large measure upon a tariff enacted for his special benefit, not do for the party that made and maintains the tariff? The thing is too obvious to need insisting on. The more help a party receives from the controllers of tariff-fed industries the more independent it is of the people; and it is for the people to see to it that they are not strangled in cords of their own making. The governing power in a state ought to be under no obligations of any kind to individuals, corporations, or interests within the state; it should stand aloof from all these, in order that it may do justice to all without fear or favor, without prejudice or partiality. Until this condition prevails it is absolutely impossible that we should have honest government in the full sense of the word. It is evident then what the next step in the purification of our national life must be: it is the freeing of the governing power from all dependence on, and all entangling alliances with, private interests. We believe that, were this done, a higher standard of public duty and a nobler tone of public life would at once be established; and we should begin to see more clearly how, in other respects, our administrative methods might be improved. The ideal of a free state is the largest possible measure at once of liberty and security for the individual citizen, and the widest possible scope for spontaneous social activities. We are well aware that, even in this enlightened community, not every citizen takes this view of the matter; that the old idea of government as a kind of earthly Providence to whom prayers may be addressed on all possible subjects, and whose powers of interference with the natural course of things are, and should be, unlimited, more or less prevails. We trust, however, that this antiquated notion is on the wane, and that within the next few years our people will take a decided step in advance in freeing themselves from the thrall of unnecessary state interference with individual action. We shall never know what, as a people, we are capable of till we take our industrial and commercial activities into our own hands, and instruct our legislators that we shall not in future consider it one of their tasks to make this country wealthy and prosperous.

MORAL ENDEAVOR.

There has recently sprung into existence a society of vast extent, the professed purpose of which is to promote the doing of good deeds by its members. We refer to the Society of Christian Endeavor, a monster convention of which was held in this city two month ago. So far as its main object goes, it is impossible to find any fault, even were one so disposed, with the Society of Christian Endeavor. One is only tempted to ask a little mournfully why it should be thought necessary to join a society in order to feel prompted to good deeds. We all belong to a society far vaster than that of Christian Endeavor—we are all members of the great human society. Through our membership therein we reap a constant succession of benefits of the most important character; and the question we should put to ourselves, if we have not already put it, is whether our personal attitude toward that great society is what it ought to be. It can not be what it ought to be unless we vividly realize the benefits our membership entails. To the human society we are indebted for peace and security, the protection of life and property, scope for the development of family and personal affections, access to the means of intellectual and moral growth, opportunities for æsthetic enjoyment—in a word, all that enters into the great name *civilization.* Without this society into which we are all born members we should recede into a barbarism more primitive than that of our flint-fashioning ancestors, for even they lived in societies. Language would leave us, and, with language, all higher rationality.

This great human society, like other organizations, works under conditions, and, vast as are the benefits it now confers upon us, they are not what they would be if each member consciously endeavored to advance the ends for which the society exists. It is worth while to pause a moment and think what life would be if every member of the human society were a working member in the best sense; if, by a faithful performance of duty and a kindly bearing toward our fellow-men, we were all trying to bring our society to perfection. Does any one say that the human society is too big for one to feel any affection or loyalty toward it? If so, it is not wisely said. The Society of Christian Endeavor is getting to be very big indeed—running into the millions—but is the interest in it lessening on that account? We do not hear that it is. In point of fact the human society is not too big for many to feel a deep interest in it already; and we are persuaded that, if only its claims were properly presented, multitudes could be brought to profess their allegiance to it. Every day of life thousands, nay millions, of deeds are done consciously or unconsciously in the name of humanity—that is to say, with no other feeling or motive than a desire to do good to the world at large. What is wanted is a vast extension of this feeling and the raising of unconscious service to the human society to conscious service. Who, indeed, that is not a criminal by nature would say: "I am wholly indifferent to the welfare of the social organism; if, by a slight effort, I could improve the conditions of life for numbers of my fellow-men, I would not do it"? If, then, we feel that selfish indifference to the general weal makes a man virtually a criminal and an outlaw, nothing should be required to spur us to a more diligent performance of our social duties than to be reminded from time to time of our membership in that vast society which comprises the human race, and whose constitution and by-laws are written in the civilization of our time. There is an *esprit de corps* which should animate every intelligent member of civilized society and which should make the performance of any service toward society, or toward any member of it, a pleasure. We certainly approve of the ends which the Society of Christian Endeavor sets before itself; but, in so far as it tends to obscure the antecedent obligation of every human being who lives *by* society to live also *for* society, it may, in spite of its admirable aims, be found working against rather than for the true progress of the race.

POSITIVISM IN FRANCE.

Most of our readers are probably aware that the name "positivism" was given by the French philosopher, Auguste Comte, to a system of thought and life which he professed to have founded on the unmistakable teachings of science. According to his view, the world had passed through the stages of intellectual childhood (theology) and adolescence (metaphysics), and had entered upon its maturity, the distinguishing mark of which would be the acceptance and systematic application of duly verified scientific truth. That Comte was a powerful thinker, with an altogether singular faculty for generalization, no one has ever been disposed to deny; and, although the scientific world in general has stood aloof from his system of thought as something too finished and definitive, and therefore too restrictive, for such an era of intellectual growth and expansion as the present, it has watched, not without sympathy, the efforts of his avowed followers to uphold the claims of science to a controlling voice in human affairs, and to promote the higher intellectual and moral life of society by means of popular lectures of a superior character. On the other hand, positivism has earned the hatred of the ecclesiastical foes of modern thought by the absoluteness of its rejection of their claims and pretensions. It is, therefore, an event of no ordinary importance that the leader of positivism in France, the man whom Auguste Comte designated as his successor, should have been selected by the Minister of Public Instruction to fill the newly created chair of the General History of the Sciences at the Collége de France, the most distinguished educational institution in the country. The chair was created, it is generally understood, with the express intention of offering it to M. Lafitte; and when the appointment was made it was greeted with almost unanimous approval by the press. Ecclesiastical journals, like the Univers, of course objected, and the Minister of Public Instruction had to answer some interpellations in the legislature; but, on the whole, the Government had every reason to congratulate itself on the effect produced on the public mind. Some of the comments of the Paris press are indeed very striking, showing a freedom in the expression of opinion to which in this country or in England the public is scarcely accustomed. "In these days of mystical reaction," says one paper (La Justice), "it was a very suitable thing to take strong ground for the positive and scientific spirit, and to proclaim in clear and lofty tones the one true religion, that which exalts the claims of humanity and of social duty." In defending his appointment in the Senate, the Minister of Public Instruction, after dwelling upon the intellectual qualifications of his nominee, paid the following tribute to his character: "Truly, if there is among us a modest man, a simple man, a man who has never courted notoriety, and who has reached his seventieth year without ever having asked anything of his country, it is M. Lafitte; and, for that reason, this modest and conscientious scholar, this *savant*, whose whole life has been devoted to disinterested study, appeared to us to present the moral as well as the intellectual characteristics necessary for the high dignity of a professor in the Collége de France." Again, speaking of positivism as a system, he observed: "This positivist doctrine, that people talk about and that some execrate, is an extremely tolerant doctrine; you may say that tolerance lies at its very base. Its absolute rule is to proceed by means of observation and experiment; to limit its conclusions and its affirmations to what is revealed to it by these special scientific methods; and, as regards what lies beyond verification, to treat with respect every belief and every hypothesis. Positivism is, therefore, from the philosophical point of view what the unsectarian, or lay state is from the political point of view; and I did not, therefore, think that M. Lafitte's profession of this doctrine should alarm or disturb men's consciences in this country, or prevent me from nominating him to a chair of which he was worthy."

These are notable words to have been spoken by a responsible minister in a country in which not long ago ecclesiasticism was so powerful. It is not necessary to have adopted, or to approve of, the peculiarities which mark positivism in its intellectual, and especially in its practical aspects, in order to rejoice that its most eminent teacher should have an opportunity of exhibiting its broader principles from the vantage-ground now afforded him, and of thus challenging for them, more openly than ever before, the criticism of the philosophical world. As to the action of the French Government, we can only applaud the determination it shows to place all competently represented systems of thought upon a footing of perfect equality.

LITERARY NOTICES.

Marriage and Disease. By S. A. K. Strahan, M. D. New York: D. Appleton & Co. Pp. 326. Price, $1.25.

A subject for which the progress of science is just beginning to obtain intelligent consideration is the transmission of defects from parents to offspring. While most persons have a hazy belief in the adage, "Like father, like son," comparatively few have any adequate conception of the remorseless certainty with which the physical and mental defects of parents produce degeneracy and early death in their children. The present work furnishes in a form available for the general reader an abundance of pertinent and well-authenticated facts concerning the above subject. The author states first what is known as to the general laws of heredity, and then proceeds to discuss in turn insanity, drunkenness, epilepsy, and other diseases and defects with relation to parenthood. "There is no class of diseases," he says, "so surely transmitted from parent to child as the nervous." While the chronically insane are not allowed to contract marriage, yet a young man, for instance, who inherits nervous instability may, in the intervals between acute attacks of insanity, marry and beget children. When, as probably happens, he goes to end his days in an asylum, he is very likely to be followed by some of the children whom he has burdened with his infirmity. The results are more surely disastrous when both parents belong to the neurotic or insane type. "The person, man or woman," says Dr. Strahan, "who has an epileptic, or choreic, or imbecile brother or sister, an insane uncle, aunt, or parent, or even grandparent, should never for a moment permit himself to look upon a member of any neurotic family—that is, one in which insanity, epilepsy, habitual drunkenness, suicide, or imbecility has at any time appeared—as a probable, or even possible, partner in marriage. . . . All these diseases, together with neuralgia, hysteria, cancer, and the like, are allied, and, following some law at present unknown to us, replace each other in successive generations, and in different individuals of the same generation, in a manner at present inexplicable."

In the chapter on tubercular disease, the causes which produce the consumptive temperament are given as impure air, drunkenness, and want among the poor; dissipation and enervating luxuries among the rich. This temperament occurs in families that are on the down grade of general decay. Among instinctive criminals, which are regarded as representatives of a decaying race, tubercular disease, very naturally, is found actively at work.

In the concluding chapters of the work it is shown that too early and too late marriages have an injurious effect on the offspring of such unions, while consanguineous marriages injure the children proceeding from them only by intensifying whatever defect may characterize the family to which the parents belong. Attention is called to the fact that unions of the criminal, the dissolute, and the intemperate bring forth children whose degenerate organizations make them burdensome and dangerous to those of more wholesome parentage. On the basis of these facts Dr. Strahan urges those who perceive that they possess any serious constitutional taint to forego marriage, and advocates the confinement of the criminal and habitually drunken so as to prevent the propagation of their kind.

Bibliography of the Algonquian Languages. By James Constantine Pilling. Washington: Government Printing-Office. Pp. 614.

We have already noticed the four previous numbers of the author's series of bibliographies of Indian languages—those of the Eskimauan, Siouan, Iroquoian, and Muskogean families. The whole have grown out of an attempt made several years ago to embrace within a single volume an author's catalogue of all the material relating to the native North American languages. Too much material was collected for a single convenient volume, and it was concluded to change the style of publication and issue a series of bibliographies, each relating to one of the more prominent groups of our native languages. The Algonquian-speaking people perhaps covered a greater extent of country than those of any other of the linguistic stocks of North America; and the literature of their languages is greatest in extent of any of the stocks north of Mexico, being equaled, if at all, by only one south of that line, the Nahuatl. Probably every language of the family is on record, and of the more prominent, extensive record has been made. The whole Bible has been printed in the Massachusetts and Cree languages, nearly the whole in the Chippewa and Micmac, and portions of it in a number of others. Rather extensive dictionaries have been printed in Abnaki, Blackfoot, Chippewa, Cree, Delaware, Micmac, and Nipissing, and manuscript dictionaries are in existence of Abnaki, Nipissing, Blackfoot, Chippewa, Cree, Illinois, Massachusetts, Montagnais, and Pottawatomi; grammars of the Abnaki, Blackfoot, Chippewa, Cree, Massachusetts, Micmac, and Nipissing; and manuscript grammars exist of the Illinois, Menomenee, Montagnais, and Pottawatomi. Prayer-books, hymn-books, tracts, and scriptural texts have appeared in nearly every language of the family; several of them are represented by primers, spellers, and readers; and a geography for beginners was printed in Chippewa in 1840. The present volume contains 2,245 entries of titles, of which 1,926 relate to printed books and articles, and 319 to manuscripts. Of these, 2,014 have been seen and described by the compiler; and of those unseen by him, titles and descriptions of probably half have been received from persons who have actually seen them and described them for him. Many full titles of printed covers are also given, and fac-similes of the original. The author has sought to include everything, printed or in manuscript, relating to the Algonquian languages—books, pamphlets, articles in magazines, tracts, serials, etc., and such reviews and announcements of publications as seemed worthy of notice.

Bulletin of the United States Fish Commission for 1889. Washington: United States Commission of Fish and Fisheries. Pp. 504.

The contents of this volume consist of some twenty reports on various subjects connected with American fishes and fisheries, including the taking of shell-fish. Among the more extended papers is one on the salmon and salmon fisheries of Alaska, by T. H. Bean, which is copiously illustrated with views and maps. As the salmon fisheries of Alaska are said to be more valuable than the seal fisheries, the act of Congress ordering the commissioner to make this investigation, with a view to protecting the industry, would seem to be a wise one. There is a Report upon a Physical Investigation of the Waters off the Southern Coast of New England, by William Libbey, Jr., accompanied by a large number of tables and temperature charts. Other notable papers are, A Reconnaissance of the Streams and Lakes of the Yellowstone National Park, by David Starr Jordan, with views of streams and cataracts; Notes on the Crab Fishery of Crisfield, Md., by Hugh M. Smith; and Notes on the Oyster Fishery of Connecticut, by J. W. Collins, the two last named also being well illustrated.

Tenth Annual Report of the United States Geological Survey, 1888–'89. J. W. Powell, Director. Part I, Geology; Part II, Irrigation. Washington: Department of the Interior.

During the year covered by this report, work was prosecuted in the many divisions of the survey already established, and in the new division of irrigation, created to perform the new duties assigned to the survey by Congress at the beginning of the year. The publications printed for the survey were one annual report, two quarto monographs, nine bulletins, and one annual statistical volume. In accordance with a plan promulgated by the director in December, a conference on map publication was held in January, at which a unit of publication, a system of nomenclature, and sets of colors and patterns for geological maps were determined upon. The decisions reached, and plates showing the colors and patterns, are inserted in the report. The director's report is followed by administrative reports of the heads of divisions, and by these papers: General Account of the Fresh-water Morasses of the United States, with a Description of the Dismal Swamp District of Virginia and North Carolina, by Nathaniel Southgate Shaler; The Penokee Iron-bearing Series of Michigan and Wisconsin, by the late Roland Duer Irving and Charles Richard Van Hise; The Fauna of the Lower Cambrian or Olenellus Zone, by Charles D. Walcott. The papers are illustrated by ninety-eight plates and many figures and maps.

The report on irrigation is bound separately, and describes the first year's work in this field. The area of the arid region of the United States is about 1,300,000 square miles—one third of the whole country. Major Powell estimates that 150,000 square miles of this, equal to half the present cultivated area of the country, is so favorably situated that it may be reclaimed by irrigation within a generation. The efforts of the persons assigned to the irrigation survey were directed during the year to ascertaining the whereabouts of irrigable land most eligible for redemption and segregating it for homestead settlement; to determining the amount of available water, the best locations for reservoirs and canals, the seepage, the evaporation, and the vested rights—in short, the most economical method of bringing the land and the water together. The details of this work are set forth in the report.

Psychology applied to the Art of Teaching. By Joseph Baldwin, LL. D. International Education Series, Vol. XIX. New York: D. Appleton & Co. Pp. 381. Price, $1.50.

The process of training the mind is here presented in a thoroughly methodical manner. The author divides his treatise into six parts, the first five of which deal respectively with the education of the perceptive powers, the representative powers, the thought powers, the emotions, and the will powers. These several subjects are systematically divided and subdivided, and under each subdivision the author tells in terse, vigorous sentences just what the teacher should do. For an example of his method take the following, from the chapter on Culture of the Perceptive Powers:

Habits of Exact Observation.—These habits should be formed in early life. Discriminations and assimilations should be as exact as possible, and this exactness should be rooted into habit.

1. *Sense-observation.* Great attention should be given to educating learners to gain exact sense-ideas through each sense. The power and accuracy of memory, imagination, and thought depend largely upon the extent and exactness of our sense-knowledge. Merchants must be able to test the quality of their goods by their senses. Mechanics, cooks, artists, poets, need to have the power of exact sense-observation well developed. Habits of exact observation should be cultivated early in life, and maintained persistently. Gazing around at everything, and listening to every sound, are not meant by this, but a careful attention to details, plans, and purposes.

Large use is made of tabular statements, diagrams, and different styles of type in presenting the author's meaning. The closing portion of the work, on The Art of Teaching, consists of seven short chapters. In the second of these Prof. Baldwin states and comments upon the following "Nine Laws of Teaching": "1. Be what you would have your children become. 2. Know thoroughly the children and the subject. 3. Use easy words and apt illustrations. 4. Secure attention through interest. 5. By easy steps lead through the known to the unknown. 6. Lead learners to find out, to tell, and to do for themselves. 7. Train learners to assimilate into unity their acquisitions. 8. Train pupils to habitually do their best, in the best ways. 9. Lead the pupil through right ideas to right conduct." He then proceeds to define the fundamental teaching processes, and to state which are to be most largely employed in the several periods of education. This work, with the author's two earlier books, on the Art of School Management, and Elementary Psychology, form a series in elementary pedagogy. During the past forty years the chapters of the present volume have been given as lessons to many classes of teachers, and they are now fixed in the form in which the author believes they will be most helpful.

A TREATISE ON ELECTRICITY AND MAGNETISM. By JAMES CLERK MAXWELL. Third edition. In two volumes. New York: Macmillan & Co. Price, $8.

THAT a work on electricity in this generation of electrical progress should still continue to be printed twenty years after it was written, and ten years after the death of its author, is an indication of sterling worth. Although a treatise like this, dealing only with the mathematics of electricity, is not so liable to become antiquated as one treating of the theories and applications of the science, yet Maxwell's book had a distinct forward trend which has contributed much to its longevity. The editor of the present edition, Prof. J. J. Thomson, says in his preface that the advances made by electricity and magnetism in the last twenty years are "in no small degree due to the views introduced into these sciences by this book; many of its paragraphs have served as the starting-points of important investigations"; and further, that "all recent investigations have tended to confirm in the most remarkable way the views advanced by Maxwell." In revising this work Prof. Thomson has added foot-notes relating to isolated points which could be dealt with briefly, but the chief advances in electricity that have been made since the publication of the first edition are to be treated more consecutively in a supplementary volume. He has added some explanations to the argument in passages where he has found that students meet with difficulties. He has also attempted to verify the results that Maxwell gives without proof, and where he arrives at different results has indicated the difference in a foot-note.

LONGMANS' NEW SCHOOL ATLAS. Edited by GEORGE G. CHISHOLM and C. H. LEETE. New York: Longmans, Green & Co. Price, $1.50.

THERE are thirty-eight maps in this atlas, most of them being on double-page sheets, measuring about fourteen by eleven inches, and a few being on longer folded sheets. Coloring and a variety of markings are used so as make to each give a remarkably full description of the lands and waters that it represents. There are seven maps of the world: the first showing the height of land and depth of sea in contours; the second showing ocean currents, periodical rains, and drainage; the third, in four parts, giving isotherms; the fourth showing the mean atmospheric pressure and prevailing winds in January and in July; the fifth, magnetic variation; the sixth, vegetation; and the seventh, in two parts, density of population, races, and religions. The maps of the several countries show political divisions (historical boundaries being indicated in some cases), height of the land by means of coloring, canals, battle-fields, elevation in feet of important towns, mountain peaks and passes, and the limit of navigation in rivers. There are geological, rainfall, population, industrial, and commercial maps of the United States, and one showing territorial growth, besides the general map of the whole country, and one of the northeastern part on a larger scale. To avoid overloading the maps, names of unimportant places are not printed on them, but such places may be found by means of the index, in which their locations are indicated. A sheet of astronomical diagrams is prefixed to the maps, and the volume has a thumb-index.

A Manual of North American Butterflies. By Charles J. Maynard. Boston: De Wolfe, Fiske & Co. Pp. 226. Price, $1.50.

Intending his book for the tyro as well as for the advanced student, the author has avoided the use of technical terms as far as possible. He has also made his descriptions as short as possible, and in the interest of clearness has used the comparative method wherever he could do so. The volume contains ten hand-colored plates, on which one species of nearly all the genera of North American butterflies are figured, and woodcuts are inserted in the text showing some peculiar character of about two hundred and fifty more species, by which the insects may be known. Both plates and woodcuts, with one exception, have been drawn and engraved by the author. The arrangement used is that published by Mr. W. H. Edwards in 1884.

The Rural Publishing Company, New York, publish in their Rural Library—a series of monthly issues of popular pamphlets on scientific and practical topics in agriculture and horticulture—a well-studied paper on *Cross-breeding and Hybridizing*, by *L. H. Bailey*. It considers the philosophy of the crossing of plants, with reference to their improvement under cultivation, first summarizing the results of the studies of Darwin and other authors who have investigated the subject; then setting forth the advantages of crossing within the variety and change of stock within ordinary bounds; and, finally, going on to the summary production of new varieties. This is a difficult and delicate process, calling for the exercise of the greatest skill and patience. The author records several experiments of his own in the process, all going to illustrate its uncertainty; and concludes: "Encourage in every way crosses within the limits of the variety and in connection with change of stock, expecting increase in vigor and productiveness; hybridize if you wish to experiment, but do it carefully, honestly, and thoroughly, and do not expect too much." A valuable feature of the publication is the copious bibliography of the subject.

A pamphlet comes to us from Italy discussing financial questions and reviewing the situation in that country in particular, entitled *Il Baratto dei Biglietti di Banca fra gli Istituti di Emissione e il Corso forzoso in Italia* (The Exchange of Bank-notes between Institutions of Emission and Forced Circulation in Italy), by the *Avocato Francesco Ciaffii*. The author regards the financial situation of his country as critical, and a forced circulation as imminent.

The periodical formerly known as *The Triangle* now comes to us as *Physical Education*, to which subject it is devoted. The name of the company by which it is published still remains the *Triangle Publishing Company*, and the triangle—denoting the co-operation of body, spirit, and mind—is still the emblem of its school. It purposes to publish chiefly original matter. We are glad to observe it deploring the pushing of records in special lines, refusing to hold up in prominence those who succeed in doing extraordinary work in any single line, and declaring itself committed to all-round work. It also expresses dissent with those who hold that symmetry of bodily form is the great object to be worked for, and with those who look to bodily health as the end of their endeavors. Symmetry of bodily form is an incidental good, and bodily health is only one of the objects to be pursued.

Food is a new monthly publication devoted to cookery, household economy, and good living, including foods, dietetics, adulterations, sanitation, regimen for the sick-room, new domestic inventions, and all matters of careful and healthful living, published by the Clover Publishing Company, New York.

The first three numbers, now before us, are filled with bright, suggestive, and practical leading articles on various points in domestic life, and several "departments" containing recipes, sensible household suggestions, hints, and "spicy" items. Price, twenty cents a copy.

The Journal of Physiology, edited by *Michael Foster*, with the co-operation of a number of eminent English and American physiologists, continues to publish articles of original research, and stands at the head of publications of this class in the English language. The double number for May contains accounts of investigations of taste, sensations, respiratory changes, retractile cilia in the intestine of *Lumbricus terrestris*, cobra-poison, the influence of calcium salts on heat coagulation of albumins, the protective functions of the skin, etc. Cambridge, England. Price, $5 a volume.

A pamphlet on *How to light a Colliery by Electricity* contains full directions on that subject by *Sydney F. Walker*, author of other papers on electric lighting. It gives directions concerning the number of lamps required, apparatus, dynamos, and their types, the engines that drive them, their position, lamps, switches, cables, faults, and many other points related to the subject. Published in New York by Macmillan & Co. Pp. 36. Price, 75 cents.

Dr. *Daniel G. Brinton* has printed a number of *Studies in South American Native Languages*, being papers which were contributed to the Proceedings of the American Philosophical Society in the early months of 1892. Most of them are based on unpublished manuscripts in European and American libraries, and they include material on at least four linguistic stocks hitherto wholly unknown to students. Dr. Brinton has also added two studies of Mexican languages.

Physiology: its Science and Philosophy (The Courier Co., New Castle, Ind.), is an octavo volume in which the author, *Jacob Redding*, M. D., gives his ideas of the philosophy which underlies physiology and disease.

One of the latest efforts to establish a substantial identity of body and soul is contained in a book on *Pluri-Cellular Man*, in which the questions "Whence and what is the intellect, or soul?" "What becomes of the soul?" and "Is it possible to save the soul?" are considered from a biological point of view, by Dr. C. A. Stephens. The author conceives matter as sentient or feeling, and the living body, consequently, as composed of an aggregation of living atoms, or cells. Hence the processes of life have their origins in the beginnings of Nature. The cell "is not only a modicum of protoplasm, but the instrumentality of a self, an *ego*, a personal being." The soul "is the developed and experienced living matter of the body, particularly that in the cells of the nerve ganglia and the brain." The second and third questions proposed are answered in accordance with this doctrince.

The volume of the *Missouri Botanical Garden* for 1892 contains the third annual reports of the Board of Trustees and of the director, *William Trelease*, three anniversary publications, and two scientific papers. We learn from the director's report that the garden has acquired the grasses of the herbarium of the late Dr. George Thurber, Mr. Hitchcock's collection of 2,000 specimens representing the flora of the West Indies, and Mr. Trelease's herbarium of 11,000 specimens representing 4,000 species, mostly of fungi; and the Engelmann Herbarium of about 98,000, and the Bernhardi Herbarium of 57,500 specimens, have been mounted and arranged. The anniversary publications in the volume are the Second Annual Flower Sermon, by the Rev. Montgomery Schuyler; the proceedings of the second annual banquet of the trustees of the Garden, and of the second annual banquet to gardeners. The scientific papers are a revision of North American species of Rumex, by Mr. Trelease, and "the Yucca Moth and Yucca Pollination," by Prof. C. V. Riley, with notes on *Agave Engelmanni* and *Parmelia molliuscula*. Both the papers are excellently illustrated. Price, $1.

One of the fruits of the effort of Mr. Draper, State Superintendent of Public Instruction of New York, to secure comparisons of the school system of that State with those of other States and of foreign countries appears in *French Schools through American Eyes*, which has been prepared at Mr. Draper's request by *J. Russell Parsons*, inspector of teachers' classes, formerly our consul at Aix-la-Chapelle, and author of a similar book on Prussian schools. Mr. Parsons spent a summer in the study of the French school system, and has presented a clear and comprehensive report on the subject. It is accompanied by a special paper on primary instruction in France. The two reports illustrate the educational systems of the two leading countries of Europe which pay the closest attention to elementary schools. Published by C. W. Bardeen, Syracuse, N. Y.

A valuable and well-arranged manual of the *Geography of Africa South of the Zambesi*, with notes on the industries, wealth, and social progress of the states and peoples, by *William Parr Greswell*, is published by a London house which is represented in New York by Macmillan & Co. The author alleges as a reason for the being of his work that the country is marked by the display of the power of European colonization. It "has ceased to be a country of mere sporting adventure or of aimless wanderings. It is gradually being identified with the European system; and by recent international conventions and agreements, under the Salisbury Government, boundaries have been assigned and frontiers surveyed which are likely to be permanent and beneficial to all contracting parties on the east as well as on the west coast." A large proportion of the space is taken up with the account of Cape Colony as the largest of the colonies and countries, and as having many features common to all. Maps are given of Cape Colony, Natal, and British South and Central Africa. Price, $2.

Mr. *W. Lee Beardmore*, author of *The Drainage of Habitable Dwellings* (Macmillan & Co., $1.50), has for many years past made a special study of the science of house drainage. In writing the articles, for British technical journals, of which the book has been composed, he touched briefly upon what has been done in an insanitary manner in the past, and pointed out what should be done to render a dwelling thoroughly sanitary in its drainage arrangements. While some critical readers may think he has not gone deep enough into the theory or into the practice, he hopes he has made a hearty endeavor to place before the public what should be done in order to have a truly habitable dwelling.

In *Humanity in its Origin and Early Growth* (Open Court Publishing Company, Chicago, $1.50), the author, *E. Colbert*, has endeavored to trace out a few of the salient points in the early unfolding of man and his thought, principally in those ages which preceded the writing of history; to show some of the states of development by which man was evolved from merely inanimate matter, and more especially those by which he rose from the level of his immediate predecessor in the scale of progress; then to sketch the widening out of the human mentality from the infantile phase to that of the child in knowledge, at which point it is left for history to take up the thread of the narrative. The principal object has been to discover primitive ideas about the causation of events and the constitution of things, and to show that to a great extent man's religious creeds and ceremonies, with much of his philosophy, grew out of notions which appear to have been first entertained as a result of observing the stars.

The first number has appeared of the *Journal of the United States Artillery*, published under the authority of the staff of the Artillery School. As the name of the journal implies, it is devoted to the interests of the artillery. The present number contains articles on sea-coast guns and steel armor, field practice, the English proving-grounds at Shoeburyness, the determination of the velocity of projectiles by sound phenomena, book notices, and abstracts of the contents of service periodicals.

The Department of Agriculture publishes a *Report on the Agriculture of South America*, with maps and the latest statistics of trade, which has been prepared under the direction of the statistician, *Almont Barnes*, a gentleman whose long residence in South America as United States consul, and subsequent study of the condition and progress of the South American countries, well qualify for the work. The several countries of the continent are considered each in its separate chapter, with discussions of all the points connected with the general subject.

A preliminary report on *Timber Physics*, compiled by *B. E. Fernow*, chief, and published by the Forestry Division of the Department of Agriculture, contains ample statements concerning the purpose, theory, and practical application of the timber tests now being made in the forestry division, of which a number of brief notices have already been given. The headings under which the subject is treated include the "Need of the Investigation," "Scope and Historical Development of the Science of Timber Physics," and "Organization and Methods of the Timber Examinations in the Division of Forestry."

The *Psychological Table* prepared by Prof. *W. R. Benedict*, of Cincinnati, on the basis of the teachings of James Ward and Prof. Höffding, presents on a single sheet at one view the whole course of the development of consciousness, feeling, and thought. Defining psychology as the science of consciousness, it assumes that consciousness is dependent on nerve matter, and therefore starts with affections of that. There are presented the beginnings of consciousness; its development by differentiation; sensation and the senses; representation, or the return of states of consciousness; intellection, or thought; feeling; the will; and psychical disease, the progress of which, in contrast with evolution, is called devolution.

From the annals of the Astronomical Observatory of Harvard College is reprinted a valuable compend of the *Investigations of the New England Meteorological Society* for 1890. Reports were received from 172 different observers, but owing to various changes the average number of observers was about the same as in 1889—194. There are room and need for more observers in western and northern New England. In reviewing the cyclone observations of the year, notice is taken of the course of the storms, and as far as practicable of the relations to other regions of those which passed through it and north and south of it. In the work of gathering climatic data, the attempt to prepare such general results as isothermal maps or maps of mean annual rainfall has been met with the two difficulties of an insufficient number of reporting stations, and of insufficient time since the stations have been established to afford trustworthy means for a climate so variable as that of New England. The society hopes in time to be able to attempt the preparation of tables and maps that shall portray the peculiarities of local climate on a finer scale than that which suffices very well for the country as a whole. A careful study of the tornado at Lawrence, Mass., of July 26, 1890, is given in papers by W. M. Davis, director of the society, and H. Helm Clayton, of the Blue Hill Observatory.

A pamphlet entitled *Humanity's Spreading Curse* is aimed at the exposure of the "Scribes and Pharisees," by *One of them*. The characters held up to reprobation are: "The Common Scribe," "The Moral Scribe," "The Puritan," "The Foolism Scribe," and "The Pharisee"; the question is asked, "What must we do to be saved?" and quotations are made from newspapers and periodicals to enforce the author's points. The characters aimed at by the author are doubtless all liable to criticism; but criticism is one thing, and reckless denunciation is another.

The *Annual Report* of the Geological Survey of New Jersey for 1891 (*John C. Smock*, State Geologist) is full of valuable facts and statistical data concerning the resources of the State, and of suggestions for their further development. The work of the survey was carried on during the year in the study of the surface or Pleistocene formations in the northern part of the State; in an examination of the oak-land and pine-land belts of the southern part of the State; in the continued study of the stream-flows and water-sheds for the report on water-supply and water-power; and, in co-operation with the United States Geological Survey, in the study of the crystalline rocks of the highlands of northern New Jersey. In addition to a very satisfactory presentation of these subjects, articles are given on "Artesian Wells," "Passaic River Drainage," "Iron Mines," and "Mineral Statistics." The detailed study of the drift and of the glacial moraine and its topographical characteristics is full.

A convenient manual of the *Elements of Materia Medica and Therapeutics*, compiled from the British Pharmacopœia of 1885, and its appendix of 1890, by *C. E. Armand Semple*, is published by Longmans, Green & Co., New York ($3). While it treats in the main only of the drugs that are official, a few illustrations of non-official plants have been introduced here and there, in order to demonstrate some particular facts. The book is divided into two sections: the organic, dealing exclusively with the vegetable and animal products; and the inorganic, containing, besides inorganic substances proper, alcoholic and ethereal preparations, creosote, paraffin, etc., and carbon products generally. Stress is placed upon the illustrations—of forms of crystals and representations of plants—as tending to make the subject more interesting and to impress the facts more firmly upon the memory.

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POPULAR MISCELLANY.

Moral, Manual, and Science Training in the Boston Public Schools.—The report of Mr. Ellis Peterson, of the Board of Supervisors, on the Revision of the Courses of Study in the Boston Public Schools, begins with a notice of the rules concerning moral teaching. Teachers are expected to give instruction for a few minutes in good manners and good morals at the opening of the school, and at other favorable opportunities, avoiding sectarian subjects. Conversations and written exercises on good manners and good morals are prescribed for the upper classes. Referring to the standard of proficiency in scholarship, the report advises, that instead of considering absolutely what the pupil has accomplished, when the naturally brightest one will easily carry off the reward, the teacher should look to relative ability, and commend those who have done their best. Physical training is given through the Ling system of gymnastics. Manual training appears in the course of study for the first time. The principle on which it is given is represented in the sentence, "All drawing should be the expression of facts which they have been led by their teacher to observe in solid forms." The observation of Nature, plants, and animals by pupils is closely followed by lessons in manual training; while drawing and oral and written language are used to express the results of observation and manual work. The work of observation begun in the primary schools is continued, under the name of elementary science, in the grammar schools. The first line of work in this direction is in physiology and hygiene. Books have to be depended upon for this study, and their statements taken upon trust. "The information thus gained is of little educational value, but is believed to be of great practical use." The second line of science work is in the direction of natural history. The observation of animals, plants, and minerals is continued. Pupils are expected to study plant-life with the help of window gardening, or a school garden; to collect specimens of grains, woods, pressed leaves, and wild flowers, and of some typical animals, plants, and minerals; and to learn the relation of mineral, vegetable, and animal products to arts, industries, and commerce. The third kind of science-work required by the course of study is the observation of physical phenomena. The educational value of these lines of science-work is in proportion to the degree in which the method of work is observational, inductive, and systematic.

Muir Glacier, Alaska.—Muir Glacier, Alaska, as described by Harry Fielding

Reid, in his Studies of its features (National Geographic Society, publishers), occupies a depression in the mountain about thirty-five miles long and between six and ten miles wide. It is fed by a great number of tributaries, the largest of which are again made up of many smaller glaciers. A total area of about eight hundred square miles is drained by the system, and the actual surface of the ice is about three hundred and fifty square miles. The area draining into Muir Inlet is about seven hundred square miles. Most of the precipitation which falls on this area flows off as water in the subglacial streams; the rest, compressed into ice, is forced through the narrow gateway two miles and a half wide into the inlet, where the glacier terminates in a vertical wall of ice varying from one hundred and thirty to two hundred and ten feet above the water surface, whence large masses are continually separating to become icebergs. The water is in places seven hundred and twenty feet deep, and, as this is not enough to float a mass of ice rising so high above the water as the glacier, the ice must reach to the very bottom and must attain a thickness of nine hundred feet. The actual length of the ice-front facing the water is nine thousand two hundred feet, or a mile and three quarters. On each side the glacier sends forward a wing, which rises in the shape of a wedge over the stratified sands and gravels of the shore. The wings are fringed by treacherous quicksands, which support large stones and look firm; but the tourist who steps on them carelessly will sink in over his ankles. The ice-front has a wonderful coloring. Places from which ice has recently broken off are deep blue, sometimes almost black. This color lightens under exposure to the air and sun, and in a few days becomes pure white. All shades of blue, in striking variety, are represented in the ice-front.

The Action of Fungicides.—The principle involved in the use of fungicides for plant rusts, according to Prof. Byron D. Halsted, in the Report of the New Jersey Agricultural Experiment Station, consists in the application to the susceptible plant of a fine spray containing the substance that, when in contact with the spores, will either kill them or prevent their development. The whole practice of using fungicides depends upon the fact that these mildews, rusts, blights, and other fungous decays produce minute spores, which are easily disseminated and thereby propagate the trouble far and wide. These spores, either as such or when undergoing germination, are easily injured by various chemicals, notably the compounds of copper. It therefore follows that if these fungicides be placed upon the foliage in a thin film, it will go far toward destroying the spores already there and prevent those subsequently falling upon it from germinating. The ways in which this principle is carried out are many, depending upon the nature of the infected plant. The progress made during the last ten years in the study of fungous diseases is unparalleled. A few workers began collecting and describing some fifty years ago. This was followed a quarter of a century later by a critical study of the injurious species. The first systematic tests of fungicides do not date back more than a decade ago, and since that time, through the Department of Agriculture, experiments were begun which have been continued with well-defined practical results. By means of the experiment stations a new impetus was given to the subject about three years ago, and to-day there is a well-organized crusade against the fungous enemies of crops. The nature of the several blights, molds, and rots has been studied out in the laboratory, while fungicides in large numbers have been tested in the field. The result has been that several of the worst are practically subdued, provided the methods of warfare are followed.

Shuswap Traits.—Among the customs of the Shuswap people of British Columbia recorded by Mr. George M. Dawson is one from primitive times, by which, in the case of a man dying and leaving behind him a widow or widows, his brother next in seniority took the widow to wife. The right of a man to the widow of his deceased brother was considered as incontestable as that to his own wife or wives, and the women had equally a claim to receive from him the duty of a husband. The proper name of a man was changed from time to time during his life, when he would assume the name of some kinsman. Young men on reaching manhood were accustomed to separate themselves and go away alone into some solitary part of the country, where they would often remain for three or four months. They might hunt or trap, but must avoid contact with other people and keep away from habitations. Occasionally a young man thus engaged would clear a course in the woods or arrange bars for running or for jumping, and thus endeavor to increase his strength and endurance. They also meditated and dreamed dreams till each discovered his particular guardian spirit. Young women, at the time of reaching maturity, and thereafter at recurrent periods, were accustomed to wander forth alone after dark for considerable distances, breaking small branches from the trees as they went, and scattering them about or suspending them upon the limbs of other trees. Young fir trees, a few feet in height, were thus often split and torn apart for several feet, or the branches or growing tops were tied in knots. This custom still prevails, and the tokens of it may often be observed near Indian camps. No explanation of its meaning can be offered. An Indian who invited another to go hunting with him, gave to his friend the first deer, if several were killed. If but one was killed, it was divided, but the skin belonged to the friend in any case. If a man was hunting beyond the border of the recognized territory of his people, and one of the men holding claims to the region upon which he had thus trespassed heard him shoot, the owner of the locality would head for the place, and on arriving there expect to be feasted on the game obtained by the hunter.

Origin of the Jardin des Plantes.—According to M. Germain Bapst, in the *Revue des Deux Mondes*, the Jardin des Plantes, in Paris, was till the middle of the eighteenth century simply a botanical institution which had been created by Louis XIII in favor of his Doctor Hérouard, under the name of *Jardin des plantes médicinales et potagères*. When Buffon was appointed steward of the garden by Louis XV, he augmented its service, founded a course of lectures and a museum of zoölogy, and continued the collection of miniatures of the Duke of Orleans. On his death, in 1788, the Museum of Natural History was far less important than it is now; the rapid growth which has made it the most complete and extensive establishment of its kind in the world, began during the Revolution: First, the Royal Menagerie, which had been kept in the garden of the Château at Versailles, was sent to the members of the Commune in Paris, in 1792. They, not knowing what to do with their new charges, sent them to the *Jardin des Plantes*, with orders to the steward to accommodate them there. That was the beginning of the menagerie. The other collections originated in the custom of the princes and great lords of the eighteenth century of interesting themselves in natural history and collecting objects of different kinds. Then, when the confiscation of the estates of absconders was decreed during the Revolution, there were found in them various collections of this kind. These were turned over to the state and were deposited in the public storing-places, especially in the *Jardin des Plantes*. The French conquests throughout Europe gave them possession of numerous museums which their generals removed to Paris and placed in the national establishments. Thus the collections of the Stadtholder of Holland, and that of the Prince of Condé, kept at Chantilly, came to constitute the physical and mineralogical departments of the museum.

Variety of Motions in the Atmosphere.—Espy's convection theory of storms assumes that the latent heat of vapor is the maintaining power, while the original ascent of the moist, warm air is due to conditions of density. Therefore, we could have no cyclonic motion without ascending moisture and clouds. The studies of other investigators have satisfied Prof. Cleveland Abbe that another important cause exists in the slow cooling by radiation and descending of the upper air flowing northward from the equator as a return trade. It eventually reaches the earth here and there in spots which are small areas of clear sky in the tropical regions, but are large areas of cold, dry air and high pressure in northern latitudes. "If the air is cooled by radiation faster than it is warmed up by the compression of its slow descent, then it reaches us as clear, cold, and dry air; and only after reaching the earth's surface does it begin to warm up in the daytime faster than it can cool again at night.

As this dry cold air underruns the moist warm air at the earth's surface, or as two areas of high pressure flowing toward each other must lift up the lighter air between them and set it into cyclonic rotation, we must, therefore, recognize the general conclusion that Espy's aspiration cyclone as developed by Ferrel is not the only form of cyclone, but that those due to descending cold air, and, therefore, having the general circulation of the atmosphere as their fundamental cause, are equally entitled to consideration. To this last and latest development from the theoretical side, I need only add that the study of the motions of the clouds has enabled me to assert that there is no form of motion known to the student of mechanics of fluids but what is to be found beautifully illustrated in some important phenomena of the atmosphere. The experiments on the motions of water and of air, and the measurements thereon that you may make in a well-appointed physical laboratory, are repeated by Nature on a large scale in the atmosphere."

Antiquity of the Wheelbarrow.—The invention of the wheelbarrow has been generally ascribed to Blaise Pascal, who lived about the middle of the seventeenth century. M. Littré, in his Dictionary, attributes it to one Sieur Dupin, in 1669, seven years after Pascal's death. M. Gaston Tissandier, however, found in a copy of the Cosmography of Sebastian Munster, 1555, a curious woodcut representing a wheelbarrow pushed by a workman. Another plate in the same book shows a tramway wagon running on rails. Still earlier evidences of the existence of the wheelbarrow have been found by M. Bixio and M. F. Guerrero, who organized the retrospective exposition of the means of transportation, which was held at Paris in 1889. A manuscript history of the sangreal of the thirteenth century contains a picture of one man shoving another in a wheelbarrow of a style now in general use. A manuscript—*Vita et Passio S. Dionysii Areopagi*—of the fourteenth century, has a representation of a wheelbarrow of another model, which is used in carrying a bundle. A very artistic picture in a manuscript—*La Vie et les Miracles de Notre Dame*—of the fourteenth century, represents a hospital where Sisters are taking care of wounded, lame, deformed, or paralytic persons, to which a man is wheeling a new patient. A miniature in an illustrated edition of *Quintus Curtius*, of the fourteenth century, shows a workman wheeling building material, who is assisted in sustaining his load by a strap over his shoulders. These evidences testify to the use of the wheelbarrow as early as the thirteenth century, and it may have been an old invention then.

Trees and Extreme Temperatures.—The power of trees, says a note in Garden and Forest, to regulate their own temperature to a certain extent is seen in the fact that their twigs are not frozen through in winter; nor does their temperature increase in summer in proportion to the temperature of the surrounding atmosphere. The bark is a bad conductor of heat, and is to a certain extent the clothing in which the plant is wrapped. The surface evaporation of the leaves produces in summer a freshness in them that causes them to feel cool even on hot days. Evaporation, however, does not explain the coolness of many kinds of fruit that are inclosed in a hard envelope, through which it seems almost impossible. Hooker mentions a fruit grown by the Ganges in a soil having a temperature of from 90° to 104°, the temperature of the juice of which had only 72° Fahr.

Liquid Air and Liquid Oxygen.—A lecture was recently delivered at the Royal Institution, London, by Prof. Dewar, embodying the results of his recent investigations into the properties of matter at excessively low temperatures, and in particular of oxygen and atmospheric air in the liquid condition. The lecture was illustrated by experiments such as have never before been attempted in a lecture-room. Liquid oxygen was produced in the presence of the audience literally by pints, and liquid air was handed round in claret glasses. While oxygen boils in air at 182° C. below zero, the researches of Lord Kelvin and Prof. Tait indicate that temperatures below −274° C. will not suspend all the activities of matter. As this is far below even the calculated boiling-point of liquid hydrogen, the absolute zero seems to recede as we advance. The purely chemical relations of oxygen disappear in the liquid condition. Phosphorus or potassium may be plunged into the liquid without any sign of combination. But the magnetic properties of the gas are intensified, and the action of the liquid upon light is identical with that of an equivalent quantity of oxygen in the gaseous condition. But while thus strongly magnetic, liquid oxygen is an extremely bad conductor of electricity. The boiling-point of liquid air is 192° C. below zero, or 10° C. lower than that of oxygen. The doctrine of the text-books that the oxygen liquefies first and the nitrogen afterward is erroneous. Air liquefies as air; but the boiling liquid parts with its nitrogen first, and becomes gradually richer in oxygen. Both in appearance and in spectroscopic behavior liquid air is simply diluted liquid oxygen. The blue tint of the oxygen is lost, and the absorption bands in the red are proportionately faint. Were this globe cooled down to some 200° C. below zero, it would be covered with a sea of liquid air thirty-five feet deep, of which about seven feet would be oxygen.

The Eleventh Census.—In an address delivered before the American Statistical Association Robert P. Porter, Superintendent of the Eleventh Census, stated that sixty thousand persons took part in the work of this census, and that its reports will make not less than twenty-five quarto volumes of one thousand pages each. Of the thirty experts and chiefs of divisions, at least twenty-three held similar or prominent positions in the tenth census. By the use of the electric tabulating machine it has been possible for the first time to aggregate from the schedules all the information which appears in any way desirable. Taking warning from the fate of educational statistics in the tenth census, which largely failed of publication, it was determined to confine the inquiries in the eleventh census to a small number of essential questions most readily answered. The statistics of mortgage indebtedness was a novel feature of this census. Under this head was made only the simple inquiry whether the farm or home was owned or rented, and, if owned, whether free from debt or not. Although these and some other inquiries increased the cost and added to the difficulties of the constitutional enumeration, the superintendent is confident that the work did not thereby suffer to any serious extent. In conclusion, Mr. Porter points out some defects of our census system, and urges a permanent Census Bureau.

The First Cigars in Paris.—Some interesting information has recently been published respecting the time when cigars first came into use. A passage in Hippolyte Auger's *Mémoires*, now very rare, relates that "our return to Paris (in 1823) was made by way of Orléans. On the road we met quite frequently officers returning from Spain. They swaggeringly had cigars in their mouths—a new habit, which has since become general." Another document carries back the use of the cigar to a somewhat earlier date. The *Hermite de la Chaussée d'Antin* (vol. iv, 1813), going to call upon his nephew, a young officer on leave in Paris, found him at his hotel in morning costume with a black silk cap on his head, and smoked a Havana cigar with him. The taste for the cigar was so common at that time that grocers, alive to their interests, were accustomed to present them to their customers. A set of complimentary verses, composed by Armand Gouffé for the actor Chapelle, of the Vaudeville, who had added to his professional occupations dealing in colonial produce, included in the nomenclature of articles that might be obtained in his shop—

"Gum, marshmallows, rum and rack,
Barley-sugar, almonds, and cigars."

Natural Selection among Egyptians.—"In spite of what appears to us a meager bill of fare, the Egyptian fellah," says Prof. Robert Wallace, "is very often a man of splendid physique, superior in strength and in endurance to the Indian ryot, whom he strongly resembles in many of his ways of working, his habits, his stolid lack of nervousness, and the absence of fear of sudden danger to his person. It is believed that the fellahin are almost exact reproductions of their predecessors for generations, and that, although the country has been frequently conquered, the new-comers were insignificant in numbers to the mass of the people, and consequently became rapidly absorbed. It is also a common belief that the soil and climate, and possibly the Nile water, exercise an influence in producing a certain type; for example, the nut-brown skin of natives of Lower Egypt. This is so, but the direction in which the influence works is frequently misunderstood. The result is more probably brought about by natural selection than by the modification in a given direction of the individual units of successive generations. Thus the negroes, though coming in numerously and intermarrying with the Egyptians, gain no ground, because the climate of the Delta is unfavorable to them, and they die of pulmonary disease within a few generations. Again, Europeans and strangers to the country generally suffer and die from typhoid fever in vastly greater proportions than the natives."

Magnifying Glasses in Antiquity.—Probably the earliest mention of magnifying glasses is quoted by Mr. Henry G. Hanks, in the Papers of the Astronomical Society of the Pacific, from the Vanity of Arts and Sciences of Henry Cornelius Agrippa, of the early part of the sixteenth century, where it is said: "So we read, as Cœlius in his ancient writings relates, that one Hostius, a person of an obscene life, made a sort of glasses that made the object seem far greater than it was; so that one finger should seem to exceed the whole arm, both in bigness and thickness." There is difficulty in fixing the date of Cœlius, but he probably lived before Livy; and Hostius was a still more ancient personage.

Funeral Customs in New Guinea.—The death of a chief recently gave the Rev. S. B. Fellows, one of the Wesleyan missionaries in New Guinea, an opportunity of observing the native funeral ceremonies, which are somewhat similar to those of the Maories. From the time of death until burial, the corpse lies on the floor of the house, with no other covering than it had in life. In the present case a man, a near relative, was seen lying across the corpse, which he hugged and stroked, with loud crying and bitter sobbing. The women kept up an unceasing wailing and crying, signs of a grief which seemed genuine enough. The virtues of this chief were chanted as the mourners repeated again and again the names of the islands he had visited in his canoe, the amount of food he had brought home, the fish and pigs he had caught, etc. Large fires were kept burning underneath and round the house during the night to scare away the "debil debil." On the morning of the second day after death, the body, wrapped in rough mats, was buried soon after sunrise, without any rites; and on that day a feast was made for the friends and mourners. An old cocoanut palm, of great value, is cut down, and the leaves are used for the roof of the small house that is built over the grave. At the funeral of a woman a yam was placed on each side of the head, and a native cooking-pot with the bottom knocked out was put on the head cap-fashion. A dish of cooked food is passed up and down the corpse before it is covered; and an annual offering is made at the grave. The soul of the dead person, called *barnaqum*, is supposed to linger near the body until it is buried; then it quietly takes its departure, by way of the mountains of Misima, for a place deep down in the earth, called *tuma*. Souls are permitted to revisit the earth, when their presence is made known by a peculiar low whistle. After remaining in *tuma* for a long time, they undergo a change similar to the death of the body, and are then transmigrated to the bodies of infants yet unborn.

Development of Exotic Gardening.—Charlemagne is called, according to the Gartenlaube, the first æsthetic gardener in western Europe; for he it was who took pains to transplant into German gardens the useful and ornamental plants that grew wild in the woods and the fields, and to introduce those which flourished beyond the Alps. As men increased in good living and their tastes became refined, they were not satisfied with useful plants alone, and the gardens of the more wealthy were adorned with the choicest ornamental and fancied plants of the East. The proverb, "Gardens are visiting-cards; what they are shows what their owner is," is illustrated in the history of the development of the German garden, which is really a chapter in the history of civilization. With great extension of trade in the beginning of the sixteenth century, rich acquisitions were made to gardens from all foreign countries — a process of growth which has not yet ceased, but seems to be going on more actively than ever. Prof. G. Kraus has well said that, if some giant hand should remove at one stroke all the plants which have not grown native among us from time immemorial, our gardens and large spots in our cultivated fields would be reduced to the condition of deserts. From the annals of the botanical gardens, beginning with the establishment of that of the University of Padua, in 1545, an important chapter could be gathered in the history of the migrations of plants. A few American guests appeared there about the middle of the sixteenth century, which were at first called Indian or Spanish plants. Among them was the *Papas peruanorum*, which was cultivated as an ornamental plant without a suspicion of its coming destiny—the potato. There were preferences among the strangers, and the fashions changed; Oriental bulbs were succeeded by Canadian plants, among which the Robinia, or locust, the Virginia creeper, asters, and evening primrose, were high in favor. Then came greenhouse plants from the Cape of Good Hope—scarlet pelargoniums, dracænas, charming heaths, and others, which are still in favor. American trees were then sought for park plantations, with the crab-apples and flowering shrubs of Siberia. After these improved commercial facilities favored the introduction of the curious eucalypti and other plants of Australia; botanists are traveling everywhere with their Wardian cases, collecting and bringing safely home the rarest and most delicate orchids and palms of the tropical forests, and plants of every region where vegetation flourishes. About 1,500 species of plants grow wild in England. In 1891 there were cultivated in the botanical gardens at Kew 19,800 species and varieties; in Berlin, in 1890, 19,000 sorts; and in St. Petersburg, 25,000 varieties with 71,850 specimens.

Chinese Characters and Hieroglyphics.—In a paper on the social and religious ideas of the Chinese, as illustrated in the ideographic characters of the language, Prof. R. K. Douglas shows that the Chinese ideographic characters are picture-writings, and as such supply an interpretation of the meaning of words as they were understood by the inventors of the characters representing them. These characters, developed from the original hieroglyphic forms, were considered illustrative of the ideas of the people on political, social, scientific, and religious subjects. For example, the importance attached to the qualities of the sovereign is exemplified in the choice of the symbol employed to express a supreme ruler, the component parts of which together signify "ruler of himself." By means of the same graphic system a kingdom is shown as "men and arms within a frontier." The domestic life is illustrated by ideograms descriptive of household arrangements and relationships. The speaker in succession traced in the written characters the ideas associated with men and women—their virtues and failings; the notions associated with marriage; and the evidences of pastoral and agricultural habits among the people. The discussion of the popular religious faiths showed how prominent is the belief in the god of the soil, whose presence brings blessings, and whose averted countenance is followed by misfortunes.

Death-week in Rural Russia.—Some very curious ceremonies are observed by the peasants of rural Russia, on the breaking up of the ice toward the end of March. The breaking is supposed to be due to the water-spirit, who, waking hungry and angry after his winter's sleep, bursts the ice and sends the floes drifting, drives the fish from their haunts, and causes the streams to overflow. Previous to this the peasants prepare a sacrifice as the beginning of their "death-week" celebration, to be offered to the spirit. They combine to buy a young horse, which must be purchased, not given, each contributing an equal amount. The horse having been sumptuously fed for three days, is taken on the fourth day at midnight, decorated, conducted by all the villagers in a body, tied, weighted, and plunged through a hole in the ice. In some districts fat, in others a horse's head, is thrown in instead of a living horse. A sacrifice is then made to the house spirit. A fat black pig is killed and cut into as many pieces as there are residents of the village, of which each resident receives one and buries it under the doorstep at the entrance to his house. The principal ceremony of the season is that of driving out death. All the villagers bring old clothes, rags, straw, sticks, and other stuff of the kind, from which a dummy figure representing an old woman is made, and painted as hideously as possible, to represent death—death being a woman in Slavic mythology. The figure is perched on a long pole and carried by a peasant dressed in what are left of the rags, etc., who is accompanied by a procession of the people provided with everything with which they can make a noise. The dummy is carried to the nearest river or stream, and cast into the water, or sometimes only ducked, and then thrown upon the nearest piece of vacant ground, or sometimes cast into the territory of a neighboring village, when a quarrel is likely to arise. On returning to the village, more noisy instruments are collected, and the men, women, and children run round to drive out the evil spirits death is supposed to have left behind. The faster the people go, and the more noise they make, the more effectually the place is supposed to be cleared, and the greater will be the blessings of the coming season. To make all sure, the villagers camp out for the night, to wait for the hour when the gates of heaven are supposed to be opened, and special blessings asked for are granted. All the trees are said to bear golden fruits at that instant, and whoever is lucky enough to grasp them just then can keep them as his own. Unhappily, the people are always too wearied with the day's work and drinking to be alert enough to seize the exact moment.

The New Stone Age in Iceland.—According to a lecture before the English Society of Arts on Iceland, by Dr. Tempest Anderson, in the more remote parts of the country, such as the Skaptadals, many articles of bone and stone are still in use which in more accessible districts have been replaced by metal or earthenware. A photograph exhibited showed a wheelbarrow with a stone wheel, a steelyard with a stone weight, a hammer with a stone head, and a net with bone sinkers. At the same farm a quern, or stone hand-mill, was in use, and also horn stirrups, and harness fastenings of bone instead of metallic buckles, bone pins, and rude bone dice. At a neighboring farm was a basin formed of the cup joint of a basalt pillar. Truly we still have a survival of the stone age. Less remote than this is the meeting-place of the county council of the district in a spacious cave in the lava. It would be difficult to find anything more appropriate in such a primitive land. Mr. E. Magnusson, speaking on the author's address, said that in some places the people, though descended from those who had long left the stone age behind, had found it necessary, because it was so difficult to procure iron, to create a new stone age for themselves. They were the creators of a new stone age, not the followers of a tradition.

Oxygen by the Brin Process.—The manufacture of oxygen on a commercial scale is developing into a new and important branch of business enterprise. The process employed, called the Brin process, depends upon the property of barium monoxide of absorbing oxygen from the atmosphere when heated to about 1,000° F., and giving it off again at about 1,700° F. Barium oxide closely resembles lime, and is found combined in nature as heavy spar and witherite. The nitrate, commercially known as baryta, is used. In the preparation of oxygen, air is forced by pumps into retorts containing baryta, where the oxygen is absorbed and the nitrogen is allowed to escape. When sufficient air has been pumped in, and after an interval, the process is reversed, and the oxygen yielded by the baryta is pumped into a holder. It is sent out to consumers compressed to a pressure of eighteen hundred pounds to the square inch, in cylinders of steel, ranging in size from three and a half to five and a half inches in diameter, and from one to eight feet in length. It is used in laboratories, in various manufactures, in medicine, as a disinfectant, and in the calcium light.

A Versatile Animal.—Among the curious animals of the pampas, described by Mr. W. H. Hudson, in his Naturalist in La Plata, is a hairy armadillo, an animal that will live on almost everything, from grass to flesh; that catches mice and kills poisonous snakes, "and having killed them, cuts them in pieces and swallows as much as it needs. . . . It is much hunted for its flesh," says Mr. Hudson, "dogs being trained for the purpose; yet it actually becomes more abundant as population increases in any district; and, if versatility in habits or adaptiveness can be taken as a measure of intelligence, this poor armadillo, a survival of the past, so old on the earth as to have existed contemporaneously with the glyptodon, is the superior of the large-brained cats and canines."

Destruction of Quail and the Plague of Locusts.—The great and fearful increase of locusts in Algeria is ascribed by the French journal *L'Éleveur* to wholesale destruction of quail by sportsmen. It is estimated that a quail consumes daily from fifty to sixty grammes of food, and that twenty tiny locusts of the size of a hemp-seed go to a gramme. Hence one quail may destroy daily 1,000 locusts, or from 20,000 to 25,000 during the period when the insects are small enough to be swallowed by it. The Tunisian sportsmen who on the 8th of May of last year shipped off 50,000 quails to France are, then, in a great measure to blame for 150,000,000 locusts less than usual having been destroyed by those birds during the year.

NOTES.

The portrait of William Bartram, referred to in the Popular Miscellany department last month, is inserted as the frontispiece of this number of the Monthly. A sketch of John and William Bartram appeared in our number for April, 1892.

A curious series of experiments on the hereditary transmission of mutilations has been made by Dr. C. G. Lockwood. By the in-and-in breeding of white mice for ninety-six generations he obtained a larger and finer animal than the original pair. In order to breed their tails off, he selected a pair and putting them in a cage by themselves and clipping their tails he got a breed of tailless mice in the seventh generation. Then, by taking one with a tail and one without a tail, and alternating the sexes in each generation, he finally again got a breed of all-tail mice.

It results from the researches of Mr. C. M. Pleyte, of the Ethnological Museum at Amsterdam, that the use of the *sumpitan*, or blow-pipe, and of the bow, is separated by a line corresponding with that which distinguishes between the western and the eastern branches of the Malayo-Polynesian languages. The *sumpitan* is found nowhere to the east and the bow only sporadically to the west of the boundary. It is ingeniously argued that the blow-pipe was the primitive instrument, from the fact that it survives as a toy where it has ceased to be a weapon.

The debate on the fitness of aluminum to be used in food-vessels is continued, with the report of the experiments of M. Balland. He discredits the representation that it is too readily corroded by many food-substances, and finds that air, water, wine, beer, cider, coffee, milk, oil, butter, fat, etc., saliva, and other substances have less action upon it than on such metals as copper, lead, zinc, and tin. Vinegar and sea-salt attack it, but not violently enough to make its use hazardous.

The works of Prof. Wilhelm Weber, the physicist, are to be published by the Royal Society of Science at Göttingen.

The optically inactive form of tartaric acid, known as racemic acid, has been obtained by M. Gensesse as an eventual product of the action on glyoxalic acid—an acid found in gooseberries, grapes, and other fruits—with nascent hydrogen liberated from a mixture of zinc-dust and acetic acid.

A fund, called the De Laincel fund, has been dedicated to the promotion of the study of the graphic system of the ancient Mayas, by collecting vocabularies and obtaining reproductions of the mural inscriptions of Central America and of their manuscripts. The work will be carried on under the direction of a committee of recognized qualifications; and the explorations will be directed by Dr. Hilborne T. Cresson, of Philadelphia, an experienced ethnologist and a Maya student.

A novel view of the puma, or panther, as it is commonly called, is taken by Mr. W. H. Hudson, in his Naturalist in La Plata, who insists that it never attacks man except in self-defense. In the Pampas, where it is common, the *gaucho* confidently sleeps on the ground, although he knows that pumas are close by; and it is said that a child may sleep on the plain unprotected in equal security. This is not on account of fear or dislike of man, but of an apparent cat-like fondness for being near him. The *gauchos* call the animal "the friend of man."

Interest in stilt-walking—concerning which we published an illustrated article several months ago—has been revived by a stilt-walking match which was contested on the 27th of May last, under the auspices of the journal La Gironde, of Bordeaux, France. The course, from Bordeaux to Biarritz, 257 kilometres, was passed over by the victorious contestant in 55·30 hours, or at an average speed of 4·650 kilometres per hour. This is not much if any better than could be done by an ordinary walking-match pedestrian.

Remains of a mammoth and other prehistoric animals have been found in Endsleigh Street, London, at a depth of twenty-two feet below the surface. They include two tusks nine or ten feet long, one of which is two feet in circumference at its thickest part, and a lower jaw and other bones of a younger mammoth. The seeds of about twenty species of contemporary marsh-growing plants have been found in the soil in which the remains were imbedded.

The American Metrological Society has prepared a petition asking Congress to order the metric system to be used exclusively in the customs service in the United States. The Geographical International Congress at Berne, Switzerland, last year, entreated English men of science in future to use only the units of the metric system in scientific and technical publications. The new Decimal Association in London has petitioned the proper authorities to prepare alternative questions, based on the metric system, to be used at the option of the candidate in the May examinations of the Science and Art Department.

A novel and interesting feature of the first United States Food Exhibition to be held in Madison Square Garden, New York, in October, will be a national exhibit of dairy products. It will be in charge of Prof. James Cheeseman, a recognized dairy expert and authority in all matters pertaining to dairy interests, who represented the United States in that department at the late Paris Exposition. He is also known to our older readers by his suggestive article on Selection in Grain-growing, in The Popular Science Monthly for July, 1883.

We are informed by the Rev. Stephen D. Peet of the existence of three considerable collections of cave-dwellers' relics in the West—one in Denver, one in Chicago, and one in the far West. The relics in the collection of the Rev. Mr. Green in Chicago were carried two hundred miles on horseback, from Grand Gulch in Utah, a distant and retired branch of the San Juan Valley.

Dr. Cyrus Thomas announces in Science that he has at last discovered the key to the reading of the Maya Codices, and probably of the Central American inscriptions. The progress of decipherment will be slow, but, the clew having been obtained, it will ultimately be accomplished. The author has already determined the signification of some dozens of characters, and has in several instances ascertained the general sense of a group forming a sentence.

A remarkable ice-cave or well, at Creux Percé, near the village of Pasques, department of Côte d'Or, France, is described in *La Nature* by M. E. L. Martel. It opens horizontally in the field, is fifty-five metres deep, with a mouth forty metres by twenty, and about two thirds of the way down narrows abruptly like a funnel to ten metres by five. The ice in the bottom is plainly visible from the top. On descending, which M. Martel did very easily with a ladder, the cave is found fringed with stalactites and stalagmites of ice from ten to fifteen metres long, and six or eight by two or three metres thick. The light at the bottom is sufficient to permit the ice to be photographed.

Carnaba wax is a substance which has been used lately for hardening paraffin and making it less fusible, for improving the quality of the inferior kinds of beeswax, and in making candles, varnishes, encaustics, etc. It is derived from the palm tree known as *Copernica cerifera*, of Brazil, and is therefore sometimes called Brazil wax. It is very hard, breaks up into sharp-angled pieces under the hammer, and is yellow, gray, red, or maroon in color.

OBITUARY NOTES.

Admiral Ernest A. B. Mouchez, a distinguished French naval officer and astronomer, has recently died, in the seventy-first year of his age. His scientific career began with hydrographic and coast-survey work. He had charge of the French expedition to the island of St. Paul to observe the transit of Venus in 1874, concerning which he read a report before the five academies in 1875. In 1878 he succeeded Le Verrier as Director of the Paris Observatory. Having already organized at Montsouris a school of astronomy for officers of the marine and travelers, he carried out the same idea on a more extensive scale at Paris; and for eight years past his school has been a nursery of young astronomers for the French observatories. He also organized a curious and varied astronomical museum at Paris. He was honorary President of the Astronomical Congress which has met three times at Paris; and he is credited with having conceived the idea of the map of the sky in the making of which all civilized countries are now co-operating.

The death is announced, at Buenos Ayres, May 2d, of Hermann Burmeister, the dean of South American naturalists, aged eighty-five years. He was of German birth, was Professor of Zoölogy at the University of Halle, and took up his residence in South America after having made several voyages there. Since 1861 he had been Professor and Director of the Museum of Natural History of Buenos Ayres, and Curator of the University of Cordova. Besides several works of natural history published in Europe, he was author of many important studies on the fauna and paleontology of South America, the most considerable of which were published in the Anales of the Public Museum of Buenos Ayres, a periodical founded by him, and of a Physical Description of the Argentine Republic. He is credited with having given an "enormous impulse" to science in South America, particularly in the La Plata countries.

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AMERICAN CHILDHOOD FROM A MEDICAL STANDPOINT.

By HENRY LING TAYLOR, M. D.

A GOOD deal has been said and written about our national temperament and physique, and it is doubtless true that the various stocks of the Old World, transplanted to our soil and subjected to new conditions of life, have felt the molding influences of changed surroundings. The human organism is preeminent in its marvelous adaptability to the most varied conditions of life. It has complex mechanisms which convey, store up, modify, and discharge the showers of impressions constantly received through nerve-endings in the skin, membranes, and tissues, as well as through the organs of special sense. We recognize that different individuals and races react somewhat differently to stimuli; they have inherited or acquired special characteristics of mind and body, largely due to habits evoked by special surroundings and ingrained by frequent repetition, whether in themselves or in their ancestors. If inherited bias counts for very much in molding the organism, this is equally true of impressions frequently repeated, or the steady push of constantly acting, though it may be scarcely noticed, forces.

Conspicuous factors in modern life are the extreme specialization of pursuits and occupations tending to narrow and restrict experience, and the herding together of dense masses of population in large cities, toward which the more venturesome and ambitious individuals tend to gravitate, and where larger opportunities are provided, only at the cost of more strenuous competition, and in many respects less favorable hygienic conditions. Success is paid for, both directly and remotely, in pounds of flesh.

It has been claimed that the strongest blood can not endure continuous city life for more than three generations, but must be kept alive by the infusion of country blood or by the return in some degree to country life. Thus our large cities are a kind of biological furnace, which in the end consumes the lives supplied to it, in order to obtain the product in trade, science, and art which we so much admire. If, in the course of this fiery ordeal, the individual receives a keener temper or a finer polish, he may not become stronger physically or better balanced mentally, and thousands, unable to endure the strain, are cast off or incapacitated, while hundreds of thousands are not able to transmit to their children the physical endowment which they themselves originally possessed. It is the purpose of this paper to study the physiological tendency of the forces to which many American children are subjected, especially in our largest cities, where the logical effects of characteristic habits or traits are most strikingly evident. Physicians know that city children get too little light and air, do not take enough of the right kind of exercise, are often overfed or underfed, are pushed or pampered too much in their studies, and especially in their emotions, and frequently shorten their childhood to become little men and women before emerging from pinafores and knickerbockers. Such criticisms have been frquently passed, and that they are not unfounded we can all testify.

We instinctively recognize more truth than jest in Henry James's description of the little girl who rushed into the hotel parlor on roller skates, shouting: "Get out of the way!" and we have at once a clear mental picture of her pale, eager face, slim figure, shallow chest, attenuated limbs, and weak ankles; so inevitably does the simple exclamation suggest a correlated and too familiar physique. Healthy immigrants, or country people coming to the city to live, usually lose their fresh, ruddy color in a few months, and their firm flesh becomes flabby, though city people are, as a rule, better walkers and can stand more of certain kinds of exertion. We may take the physique of the little girl on roller skates as a type of frequent occurrence. In children of the corresponding class the feelings may be intense or sluggish, but in either case betray the lack of proper balance and correct discipline. There is a precocity in knowledge of people and social relations, darkest ignorance with regard to most natural objects and processes. The mind and body may be restlessly active or listless and indolent; in either case the fundamental qualities of docility and poise are lacking; there may be much development on the æsthetic side, or much in comparison with the neglect of the practical. The city child is handicapped from the start. He is usually produced with difficulty from overtaxed and under-nourished, not necessarily underfed, stock rather than from the superabundant vitality of robust natures. The cultured mother rarely has sufficient vigor to nurse her infant, and it is brought up on some substitute, which at the best is but a makeshift. Whatever modern life and culture may have done for our women, they hardly seem, in their extreme forms, to have prepared them for the intelligent care of their offspring, whose arrival is often regarded with pathetic helplessness. There is, however, enough of New England's "inflamed moral sense" in our midst to furnish our women with a fair share of conscience, so that their errors are as apt to be due to over-solicitude as the reverse. Take the matter of clothing, for example: this is frequently piled on till the hapless youngster presents the appearance of a bale of millinery, impeding movements, keeping the child over-heated, and forming a conspicuous part of the hot-house life which the child is henceforth to lead. Literally "hot-house," for there is something in our houses, their heating apparatus, or the habits of the people, which keeps our residences at a tropical heat during the cold season. I am inclined to think it is partly a result of our high-pressure life. A tired brain and exhausted nerves crave warmth; and indolent or sedentary habits do not predispose one to bear a bracing temperature. Be that as it may, the little ones grow up in an atmosphere of steady, relaxing warmth, and the continual endeavor is to protect them from anything approaching cold. Their baths are usually hot, and there is a noticeable absence of that skin culture which comes naturally to country children, living out of doors, sleeping in a cold room, skating or snow-balling in winter, and swimming in the neighboring pond in summer. It seems that the whole tendency of city life is toward "making it easy," physically, for the individual by the elimination of all except the simplest demands on the organism, forgetting that our powers are developed by their cultivation, and inevitably deteriorate with disuse. Our life is so artificial that we require gymnasiums, field-sports, and outings to keep a decent physical equilibrium, and we ought in addition to give particular attention to vascular gymnastics and to the culture and development of the unstriped muscular fibers, which play so fundamental a part in vital economy, by placing more dependence on their adjustive and resisting powers, through a systematic and judicious exposure of the skin to cold water, cold air, and the vicissitudes of weather. As to the diet of children after the nursing age, it is likely that our city children fare better than many of their country cousins. There is probably no country in the world where there is such an attractive variety of cheap and wholesome food of all classes, meats, cereals, vegetables and fruit, as in our own. The general habit of fruit-eating, which seems to be growing, is, I believe, salutary, and to be encouraged. Good fruit is practically within the reach of all at all seasons, and we are probably the only nation out of the tropics where fresh fruit is a staple article of diet every day in the year. The temptation and tendency in the diet of children is toward an over-indulgence in animal and saccharine food, and in elaborate made dishes; and the practice of allowing children to eat at the same hours with their elders, and substantially the same things, is liable to result in a trying regimen for the child.

In regard to fresh air, the youthful citizen of the metropolis is not likely to get too much of it indoors, and the few hours a day spent on the sidewalk or in a perambulator are a sorry substitute for rolling over the grass or tumbling about the door-yard. When the child is a few years older the difficulty is increased. Young children are in constant motion, and this is Nature's method of educating the muscles and nerve-centers in the selection and development of those complicated associated movements and correlated reactions which finally form the automatic groundwork of our life. We are brought by these means into contact with all kinds of natural objects, in order that we may become aware of their attributes and react promptly and advantageously to their stimulation. The city child, however, instead of soil with its diversified coverings, has hard and mostly level floors or pavements; instead of grateful greenish, bluish, or brownish tints, the patchwork surface of our houses and streets; and instead of restful silence or simple and harmonious sounds, the irritating jar of complicated, intense, and discordant noises. We may compare the conditions to which the city child is subjected to the life of a trainman, who is hampered in his movements and at the same time subjected to storms of auditory, visual, and other impressions in unending succession.

I recently had occasion to compare the development of a typical city boy of eighteen months with that of a little girl of fifteen months brought up in a small inland town. The boy was the only child of cultivated city parents; the little girl was the youngest of several children, and her parents were plain trades-people. Though the girl had congenital club-foot and had never walked, she had remarkably good control over the movements of the arms, legs, head, and trunk. She placed her finger on or grasped an object with exactness, threw a ball with force and precision, and hitched herself about the floor with great dexterity and rapidity. All her movements were well planned and well executed, and many of them complicated, such as putting a tin cup upon the end of a stick and shaking it without letting it fall off. She could speak only a few words, but had a great deal to say in her baby language. The expression on her face was placid and contented, though often animated, and she would sit for hours on the floor and amuse herself. She rarely cried, took her daily naps as a matter of course, and slept quietly all night. Teething did not annoy her, and, in spite of irregular feeding, her digestion was good.

The little boy refused to creep or sit on the floor at all, but ran about incessantly. His movements, except locomotion, were far less complicated and precise than those of his playmate. He could not put the cup on the stick, though he tried repeatedly, nor throw a ball nearly so well. He was incessantly and intensely interested in the things he saw, but only fixed his attention on an object for an instant. He had no initiative, and, as he was unable to amuse himself, he was never left alone. He talked a great deal, but not plainly, and understood nearly everything that was said to him; and it pleased him to mimic the little girl's ways and prattle. He was very fond of having the piano played to him, and could always distinguish the tunes he had heard a few times. He was bright and intelligent, and, when feeling well, very good and happy, but was a bad sleeper, and at times cross and fretful; in spite of scrupulous attention to diet, he was a martyr to indigestion, and teething caused him much suffering.

It is noticeable that many city children are thrown more among adults and less with children than is desirable, partly from the custom of relegating a large part of the parental responsibility to a nurse, partly from the small average number of children in a family, and partly from the limiting conditions of city life, which are somewhat unfavorable to real sociability. The chances are that unless a child runs the streets he will see more of two or three or half a dozen adults than of all the rest of the world put together. This is abnormal and unwholesome, as it deprives the child of the kind of mental stimulus and discipline suited to his age, and substitutes something wholly inappropriate and harmful in its tendency. When the school years come, the children have companionship, at least in school hours, but also in many instances an imperfect school hygiene, with its bad air, poor light, cramped positions, and other drawbacks. Dr. C. F. Folsom says of city school children: "Pale faces, languid work, poor appetite, disturbed sleep, headache, and what is vaguely called nervousness, are more common among them than they should be among children of their ages," and speaks of "constitutions weakened during the school years, instead of strengthened, as they should be."

On account of lack of familiarity with country life, many city children of the lower school grades, as shown by President G. Stanley Hall, have the most extraordinarily distorted ideas about the commonest natural objects and phenomena, and much of this mass of misinformation remains in adult life. On the other hand, they may be keen judges of character and conduct and be well able to hold their own in a bargain or an argument. Of a class of about thirty girls from eight to thirteen years of age living east of the Bowery, only three had been in Central Park and only four had ever visited the country. When taken to Central Park by a friend, they first asked if they might step on the grass, and then, with the natural instinct of young animals, lay down and rolled on it.

As already remarked, it is natural for the young child to move about and change its attitude almost incessantly; in the words of Sir William Jenner, "it joys to exercise every muscle"; and it is equally true that its eyes, attention, and mind should never be directed continuously at one object for very long. A child loves to glance at this object, pick up that, reach out for a third, not restlessly but wonderingly, caressingly, and joyously, just as a short time before the infant played contentedly with its rattle or its ring, waving it about or putting it into its mouth with endless repetition, but always without studious observation or strain of attention. I am afraid we often injure these small eyes and tender brains by requiring continuous repose of body and fixation of eye and attention on some one object, as is often done in the kindergarten and primary work, at the cost of ocular and nervous strain; and this combined with bad light and general driving may account for much of modern myopia, headache, and nervous troubles. We should advance in the education of muscle, eye, and brain from the general to the particular, and impose no task requiring precision or intense application upon young children. Nature is a good schoolmistress, and her lessons are fundamental ones, no matter how much we may supplement them at school or university. The infant is learning fundamental lessons, in the correlation of muscle, brain, and sense, through the almost incessant activity of his arms and legs—at first without purpose, afterward in reaching, grasping, or trying to move about, and also when it smiles back at its mother or is quieted by her voice; so is the child repeating nursery rhymes or busy with its quiet play or romping games; or the youth with his carpenter's tools, or riding, swimming, or hunting, and learning just as truly, and perhaps more truly, than the student burning midnight oil over Greek and calculus. Nature is never systematic in the school sense; and, however much we may systematize, we must at the same time cultivate our powers and round out our individuality by keeping in touch with so much of Nature and man as lies within our horizon in a restful, informal way. If a man is to develop into something more than a machine or formula, he should be encouraged from childhood to bring all his powers into relation with his environment and to seek a wide range of adjustments between himself and the outer world, beyond the tread-mill round of special or formal pursuits which necessarily occupy much of his attention. Many fail to appreciate the importance of this indispensable natural culture, and endeavor to supplant the spontaneous by the formal. I know of a little girl whose interest in flowers was destroyed by an attempt to teach her technical botany at too early an age, forgetting that it means more to love flowers than to know botany. In another case the attempt was made to substitute history for a boy's ordinary reading, with the result of spoiling the boy. On reaching manhood his favorite author was E. P. Roe.

Correct mental reactions must be based upon correct physical reactions, which are naturally evoked by a free open-air life. As Lowell puts it: "The driving-wheels of all-powerful Nature are in the back of the head. . . . But it is ill with a nation when the cerebrum sucks the cerebellum dry, for it can not live by intellect alone. The broad foreheads always carry the day at last, but only when they are based on or buttressed with massive hind-heads. . . . Moreover, brain is always to be bought, but passion never comes to market."

The city boy's supplemental training at school is far from perfect, but his fundamental, unstudied training by contact with Nature in the free use of his proper activities is wofully deficient. If restricted to the city, he can hardly become familiar with any natural objects but a few animals, building materials, and food-stuffs; his notion of such fundamental objects as the sky or horizon must be extremely hazy. His relations with people, or at least with certain individuals, are likely to be too close; he can not escape from them, and is over-stimulated or overpowered. This leads me to speak of family life as we observe it, perhaps the most important factor of all in the child's development, physical as well as mental and moral.

It is sometimes claimed that women are not as good housekeepers and home-makers as formerly, and if this be true it is not altogether their fault. It is not to be denied that the number of families in New York, for instance, is far in excess of the number of homes. The tendency with us is for the mistress of the house to participate less and less in the details of household management, and much of the work is left to hirelings inside and outside of the premises. The desire to diminish some of the difficulties of city housekeeping has caused the wholesale introduction of flats, which are, as a rule, cramped and poorly lighted, and, to say the least, ill adapted for the rearing of children. Rooms in suites have made it possible to dispense with the kitchen and its autocrat, and the disintegration of the home is complete in boarding-houses and hotels. The promiscuity of the tenement is equally unfavorable to a home atmosphere and home employments. The modest requirement of a small, plain house with light and air on all sides, is beyond the reach of the millionaire. Unless we stop to think, we are apt to forget how high a price we pay for the privilege of much laborious striving and cramped living.

So much has been said about the frivolity, incompetence, or fussiness of American mothers that it will not be amiss to inquire into the characteristics of our fathers of families. With the best intentions in the world the time that a city man can spend with his family is usually very limited, and he is not always in the mood to exert a helpful influence, when he returns at night worn out with business cares, and often prefers the club, lodge, or neighboring corner to his family circle; his wife may see little of him and his children less. It is not a matter of indifference, however, even in regard to health, whether the children enjoy a due proportion of their father's companionship, for that is or should be a vital factor in the children's growth and education, and, whenever they are deprived of it, certain elements of character and mind are almost always absent. Look around among your friends where the children have grown up without a father, and see if your observation does not show that there is some quality of mind or heart, some check or balance wanting, that no one else could supply. I observe that American fathers, whether from the exactions of business or other reasons, do not ordinarily come to my office with their ailing children. The whole matter is often left in the hands of the wife or some relative. Germans are more apt to come than Americans, and Hebrews most of all; and indeed I can not refrain from expressing my admiration of the domestic life of the better class of Jews in New York, which, so far as I have observed it, is in many respects more nearly what it should be than that of any class in our community.

Body and mind grow together; what affects the one must affect the other, so that if the influence of either parent is withdrawn the due proportion or balance is lost and certain physical as well as mental peculiarities in the children are dwarfed or accentuated. The home atmosphere often determines the mental and moral, and consequently the physical tone of the children. I claim distinctly that an atmosphere of frivolity, indolence, self-consciousness, fussiness, discontent, sentimentality, or meanness can not be without serious effects not only on the character but on the physique. Selfishness in any form is not only unattractive, but it is unwholesome; it is a depressant to the system. *Per contra*, high and well-rounded living not only makes sound thinking, but it abbreviates doctors' bills. It is a truism to say that no one has so much to do with the child's acquisition of a healthy moral and physical tone as his parents, but few realize how tremendous a factor in the evolution of the individual we touch at this point. We need the mother's influence and the father's influence in the family, and also the influence of the children on each other. First children, last children, only children, children of small and large families, all have their special attributes and defects. The child is receiving and adjusting every instant, impressions that will positively determine not only his future career but his bodily structure. Parents and care-takers must see that these impressions are useful and true. The means in the control of the physician are as nothing compared to home influences and conditions in shaping a healthy mind and body. The reactions most frequently evoked will be the dominating ones. As Bacon puts it: "Therefore since Custome is the principle Magistrate of a Man's life; let Men by all Means endeavour to obtain good Customes. Certainly Custome is most perfect when it beginneth in Young Years. This we call Education; which is in effect but an early Custome"; or as another says: "In the conduct of life, habits count for more than maxims, because habit is a living maxim, become flesh and instinct. To reform one's maxims is nothing; it is but to change the title of the book. To learn new habits is everything, for it is to reach the substance of life. Life is but a tissue of habits" (Amiel's Journal, page 7). All of which applies as cogently to the physical as to the mental. "Nothing has ever been invented to take the place of a 'bringing up.'" The home has been compared to the ship-yard where the vessel's construction is slowly and painstakingly elaborated step by step, so that the structure may be able to outride the strains and disintegrating tendencies that are sure to attack it later, just as the growing human organism is built up, under fostering influences, by the gradual incorporation of helpful habits and useful physical reactions. Self-control and transparent honesty in the parent are as essential as obedience and self-reliance in the child. "He that will have a cake of the wheat must tarry in the grinding." The child does not exist who can grow up natural or healthy without a fair share of wholesome neglect and judicious exposure. Few realize the tremendous risk of over-caution and over-attention. A youngster is invariably happier with few and simple playthings than with a multitude of complicated toys. There is no such good fun or good training as making one's self useful, and it is cruelty to deprive the child of this pleasure and stimulus. Let the brain and body be trained through hand, foot, and eye. Dump a load of sand into the back yard and let the children roll in it. Give the boys a carpenter's bench; encourage the girls to do housework. Where possible, let both boy and girl have a little garden-patch, if only a few feet square, and the care of a few plants. A woman in her home, a man in his garden: this seems to be a fundamental type from which we can not entirely depart without risk to body and mind. The training of the muscular reflexes should go hand in hand with the cultivation of simple, natural, beneficent reactions in the higher planes. Cheerfulness, sincerity, industry, perseverance and unselfishness may be acquired by practice and constant repetition, as much as the art of correct speaking or of playing the piano, and are far more necessary to health. We must have a basis of correct fundamental physical and psychical reactions as a help toward a proper balance between feeling and will, or our subsequent building will rest on a foundation of sand. How often is a physician hampered in his efforts to help some sufferer, because the latter has never acquired the art of obedience, or because he can not tolerate a tongue-depressor, or swallow a pill or any unpalatable mixture, or take milk or some mainstay of diet; or because he can not be left alone, or sleep in the daytime, or wear flannels, or sit still, or bear pain, or use his muscles, or take in certain classes of facts or ideas! These and similar peculiarities, which are a formidable hindrance to the physician, and may be a matter of life or death to the sufferer, can usually be prevented by a little care, or overcome by proper training. They are often the result of carelessness or over-indulgence, or that kind of cowardice which instinctively avoids the disagreeable, instead of facing a difficulty fairly and conquering it.

Another way in which children are injured is by being used as playthings for the amusement of relatives and friends. There is the temptation, well-nigh irresistible, to show them off, if they are bright, or later to push them along in school or society, sacrificing wholesome symmetry to immediate showy effect. This tendency has largely molded our private schools, for girls especially, whose basis is too often sentimentality of some sort; and sentimentality is a form of narrowness, an incapacity for seeing things in their true proportions.

There is one characteristic of our metropolitan life so salient that it can hardly fail to make itself felt even in childhood. I mean the mad chase after the dollar, the cause of much of the killing tension of city life. It is curious to note that the nation that is conspicuous by the absence of this spirit—I mean the Japanese—has probably the best-behaved children in the world, and is the land of happy childhood. A crying baby is to them a curiosity. This straining of powers till they crack, this incessant fiddling at the nerves, is apt to make our city life restless, asymmetrical, and unsatisfactory; the children feel it and show it in their faces, in the sensitive structure of their bodies, and in the affections and diseases to which they are subject. And this nervous tension, as much as our tropical summer climate, has necessitated that periodical return to Nature or summer outing, which is a national habit, and is the one efficient means, if properly used, of combating the disintegrating tendencies of city life.

The children of the poor, in spite of many drawbacks, fare better in some respects than those of the well-to-do. They often respond better to treatment when they are sick; they are at least not deprived of that contact with their fellows and struggle for existence which is absolutely essential to health; whereas the children of the so-called higher classes are too often educated in sensitiveness, and false and hurtful views of life, not always by precept or example, but by force of circumstances. A colleague, who is intimately acquainted with the physical condition of some eight thousand children, taken from the worst classes in New York, who have in the course of several years passed through a public institution under his care, says that they improve so much, after having enjoyed for a few months the ample diet and simple and regular life provided, that their physical condition compares favorably with that of any class of children in New York.

Much of what has been said applies to certain classes in certain restricted localities, and it may be thought that the picture is an exaggerated one, but I maintain that the physique of the children that are now growing up under our eyes is not on the whole satisfactory, and that it is a difficult matter to bring up wholesome, hearty children in New York, for example: if this is true, it is well to recognize the fact. The average conditions both within and without the family seem restricted and unnatural; fortunately, there is a large amount of sturdy stock throughout the land, brought up to individual independence in contact with Nature, and in wholesome home surroundings, upon which we can draw indefinitely.

It is true that the advantages are not all on the side of country life; that the struggle with Nature may be strenuous, and the living narrow and poor, and that on the other hand the conditions of city life may bring a better diet and a better knowledge of personal hygiene. Indeed, it is claimed that during our civil war certain city regiments stood campaigning better than the men from the country, possibly because they better understood how to take care of themselves. All this does not militate against my position that the conditions of country life are, or may be made, more favorable for children.

Just because life in our large centers puts such pressure on men and women do we get such remarkable effects in certain directions. Much of the world's best work is the direct result, but it is usually the effect of such stimulation on broad and healthy natures developed partly or wholly in the country; and ultimately, unless there are considerable interruptions, the individual or the family is stamped out, as is every individual or family which pursues a too restricted, too artificial, or too one-sided career.

SPECIFICS FOR THE CURE OF INEBRIETY.

By T. D. CROTHERS, M. D.

WHEN any great truth begins to receive public recognition it is always first welcomed by the credulous and visionary enthusiast, who surrounds it with the most extravagant expectations. This brings out the charlatan and empiric who studies to turn all such facts and conditions to his own personal profit. In this way the credulity of the one and the charlatanism of the other envelop the truth with a confusion and mystery that often conceal it for a long time. Only the student and the scientist realize that behind this glamour and illusion there is a uniform evolutionary movement along different lines from that suggested to the popular mind.

The growth of truth may be compared to that of plants—first seen in the seed, then the stalk, the shrub, and finally the tree, always following a distinct and fixed line of march through separate periods and stages. The first stage is that of indifference, neglect, and denial. Then follows the credulous period, in which the truth is partially recognized and accepted, with extravagant conceptions, associated with wild empirical efforts to incorporate it into practical life. Finally, the truth is fully understood, studied, and accepted, and becomes a part of the world's great possessions. This is the natural history of every new fact of science and every new discovery concerning the evolution of humanity. Often these stages extend over long periods of time and are unrecognized except by a few persons; or they follow each other rapidly, but always along the same lines.

The dawning truth that the drink evil is a disease, and curable as other diseases are, has passed the first period of neglect, indifference, and denial, and has come to the second stage of partial recognition and acceptance. The same army of the credulous, the enthusiasts, and marvel-hunters are welcoming this fact, and the same wild expectations of its practical possibilities fill the air. This is followed by the same old charlatanism and empiric efforts to make personal profit out of these truths by the use of the same old quackish means and methods.

These efforts are prominent by the same assumption of superior knowledge of discovery of new facts, of new remedies, and new methods, all of which are concealed. Then follow claims of extraordinary cures under extraordinary conditions, the proof of which depends alone on the statements of the cured.

Then comes the old story of persecution by physicians and scientists, and of posing as martyrs, public benefactors, and pioneer discoverers, with indirect appeals for sympathy from the broad and liberal minded. Back of all this is a pecuniary field actively tilled which yields rich harvests, and altogether it is the same old familiar history of empiricism, which is always to be found on the advancing frontiers of science. Within two years a large number of charlatans have appeared, claiming to have found remedies and specifics for the certain and permanent cure of the drink disease. A great variety of means and drugs are offered, each one claiming to be superior to all others. Recently one of these empiric specific cures has led all the others in boldness and prominence. Starting from an obscure Western village, it has spread out into many branches, all organized and conducted on one general plan, and federated together. Physicians have been enlisted to conduct each branch, companies have been organized, houses hired, and elaborated arrangements made for the work. Special papers have been established to defend its interests, and the pulpit and press have indorsed and freely praised these efforts. Every possible avenue to attract public attention has been industriously cultivated to keep the subject before the people.

Large numbers of persons who claim to be cured have organized into clubs, and display hysterical enthusiasm to prove the reality of their cure and the greatness of the projector.

It is assumed that the inventor of this specific was the first to urge the theory of disease in modern times; also that he has made a great discovery of a new remedy the nature of which he carefully conceals from the rest of the world. The most wonderful and complete cures of the most incurable cases are accomplished in two or three weeks on some unknown physiological principle. These assertions are sustained by certificates of clergymen, reformed men, and others, and are accepted as facts without question or other evidence. Dogmatic statements and bold assertions, coupled with savage criticism of those who dare to doubt, together with half-truths and wild theories, mark all the literature of this specific. The commercial side of this remedy is equally startling and Napoleonic as a business success. It is a curious fact that this particular cure is very closely followed in all its details and claims by a number of imitators, who have made equally wonderful discoveries in precisely the same way, but all are concealed for the same pretended reasons. It is equally curious to note the absence of novelty and originality of methods compared with the means and efforts used to make popular and create a sale for most of the proprietary articles on the market to-day. All these specifics for the cure of inebriety are without any practical interest except as phases of the psychology of the drink disease. It is very evident that they could not attract attention on their merits, and the means and appliances used to bring them into notice. Their existence depends on a psychological subsoil, which would favor the growth and culture of any remedy involved in mystery, and promising marvelous cures in a brief time. This subsoil is simply the expectant credulity of a large number of persons, who recognize the possibility of disease in inebriety. Without this all specifics, no matter how wisely and shrewdly presented, would fail. The conditions are all ripe for such empiricism, and its growth, life, and death are governed by causes unknown to and beyond the control of its boastful authors.

Every temperance revival movement depends on some psychological subsoil of expectant credulity, and is followed by the same dogmatic empiricism and the same wonderful cures, and hysterical confidence of permanent results. Certificates of cure, and enthusiastic praise of means and methods of far greater magnitude than that which follows any specifics, could be gathered and noted after every temperance revival.

The specific cures of inebriety to-day have appeared many times before in the history of the past. Often the empiricism associated with it has been entirely moral and ethical, and at other times it has been pecuniary and selfish. The old Washingtonian movement was a good illustration of a great specific cure, bound up with a great tide of moral empiricism, which for years created intense interest.

The presidential campaign of 1840 was notorious for the excessive use of hard cider, whisky, and rum. Every political meeting was marked by the free use of these spirits, and as the excitement of the struggle increased, temperance men drank, moderate drinkers became drunk and delirious, and never before or since has the excitement of politics been so intimately associated with inebriety in all its forms.

At the close of the campaign it was estimated that over half a million voters were practically inebriates, or had been repeatedly intoxicated during the excitement and excesses of the campaign.

Newspapers and court records showed clearly that a high tidal wave of drunkenness and moderate drinking existed at that period. Then followed the inevitable reaction, and at this moment the Washingtonians appeared. A few months before, a small drinking club in Baltimore changed to a temperance society, and called themselves Washingtonians. Its members were reformed men, and its leader, John Hawkins, was an enthusiastic, passionate orator, who urged the pledge as a remedy for drunkenness with intense earnestness. The excitement of the political campaign and its drink excesses had prepared the public mind for this great emotional remedy—the pledge. John Hawkins's infectious earnestness animated his followers, and roused up an army of lecturers which scattered to every town and hamlet all over the country. The campaign excitement of 1840 appeared again in a great temperance reform wave, which steadily grew in numbers and enthusiasm up to 1847, when a high tidal point was reached and reaction began. Over a million persons signed the pledge, and the evils of drinking and alcohol were discussed in almost every neighborhood in the country. Never before had any reform movement been prosecuted with such terrible earnestness and contagious enthusiasm. All selfish motives and personal interests seemed to disappear in the one great purpose to pledge the victim and inspire him to avoid spirits and lead a temperate life. The spirit of the old crusaders seemed to have reappeared again. This was literally a psychological storm-wave, the reaction in part of the campaign of 1840, and the outgrowth of obscure psychological conditions, which had been prepared for a long time before. It crossed the continent and was felt everywhere, and a few years later was only known in the history of the past. While a number of inebriates were restored, its real work and value were in a different direction, not yet fully realized. It seemed to be a great force that fused and mobilized a tide of oncoming truth, and was literally a forerunner, indicating new and clearer conceptions of inebriety. It not only broke up old theories, but opened up new ranges of work, and gave glimpses of more effectual methods for cure.

The first inebriate asylum in the world grew out of this movement, and all the various temperance organizations date from the same source. Even the Prohibition party is the outgrowth of this reform-wave.

It was the first great psychological evolution of the drink question, giving an impetus and inspiration to its study, above all moral and political considerations. It was also a great empirical epidemic which assumed that the drink evil was the result of a feeble will, the remedy for which was the pledge, supported by personal sympathy in organized societies. It was a moral and ethical empiricism, based on the purest and highest motives; had it been founded on truth, would have lived as a great power in the upward movement of the race. In this connection it will be of interest to trace another great wave of empiricism, that created intense interest for a time. Unlike the Washingtonians, it was thoroughly mercenary, and, like the present specifics for inebriety, it was born in mystery and sustained by credulity and dogmatism.

The experiments of Galvani in 1785 attracted great attention. The most extravagant expectation of the practical value of galvanism in curing disease gradually spread among non-experts all over the scientific world. Various empirics appeared claiming remarkable results based on this new force. Finally, in 1796, Dr. Perkins, of Connecticut, announced that he had discovered two metals which, combined in a secret way, possessed marvelous powers of galvanism, which he called tractors, or pullers-out of disease. These tractors resembled a piece of gold and silver fitted together, about four inches long, and were used, by being moved up and down over the part affected, to draw out the disease and restore the vital forces. Almost every disorder known was cured or relieved by this means. The discoverer challenged the world of science everywhere, and invited criticism, and pointed to the persons cured for irrefutable evidence. The psychological soil was prepared, and the army of credulous enthusiasts were all ready to welcome him. In two years these tractors attained great popularity in this country. They were literally recommended and indorsed by the faculties of three medical colleges, and vast numbers of clergymen, members of Congress, and public officials. A special patent was issued, and signed by George Washington, as a slight recognition of the great service the inventor had rendered the world. Pamphlets, sermons, lectures, papers, and even books were written and scattered everywhere, giving the theories and results following the use of these tractors. In 1798 Perkins went to London. His boldness and dogmatism immediately commanded popularity. After a time a hospital was established, called the Perkinson Institute, officered by the nobility, with Lord Revois as president. Large sums of money were given for the treatment of the poor by this method. Free dispensaries were opened, and trained assistants used these tractors for all cases, with boasted success. Lectures were given on the philosophy of this method, and students were instructed and sent out to open branch institutes. The rich purchased these tractors and became their own doctors, and the poor were obliged to accept treatment from others. With empiric shrewdness, certificates of cure were gathered, which exceeded ten thousand in number, and were signed by princes, ministers of state, bishops, clergymen, professors, physicians, and wealthy laymen. The inventor was recognized as a great public benefactor and pioneer, also one of the few immortals who would live down the ages. Perkinsism seemed to have won a place in the scientific history of the world. By and by this gilded cloud of popularity burst, and the charm was dissolved. Two physicians made tractors of wood and sold them as the original, producing the same results and the same crop of certificates of cure. After making a respectable sum of money, they published their experience, together with the thanks and public prayers for the great blessing conferred on the world by these means. Like the "South Sea bubble," Perkinsism dissolved and was no more. The branch institutes for treatment by the tractors closed for want of patients, and the tractors disappeared. Behind all this tremendous enthusiasm for the good of science and humanity appeared a commercial spirit that was startling.

These tractors were claimed to be gold and silver, and sold at from ten to twenty-five dollars each. In reality, they were made of brass and polished steel, at a cost of about twelve cents each, in an obscure Connecticut village, from which they were shipped to the inventor, who sent them all over the world. Of course, Perkins made a fortune, which compensated in a measure for his sudden fall from greatness.

While this was a great empirical epidemic, with a mercenary object, based on a few half-defined truths, it materially furthered the growth and evolution of this subject. Many of the wild theories which gathered about Perkinsism suggested clearer conceptions to later observers. Like the specific inebriety epidemic, it began as an assumed discovery of some new power, claimed from metals (not used), with some new physiological action by some new process, enveloped in mystery and only known to the discoverer. The tractors were patented, and only made by Perkins, and the certificates and statements of those cured furnished all the evidence. Literally, the effects were entirely mental, depending on the credulity and expectancy of those who claimed to be helped.

The present epidemic wave for the cure of inebriety is hardly up to the average of former empiric efforts in adroit manipulation of the credulous public.

The successful charlatan of modern times has always exhibited some psychological skill in the display of assumed truth and the concealment of his real motives. In these inebriety cures there is a coarseness of methods, with brazen assumptions and display of pecuniary motives, that quickly repel all except the unthinking. The circulars, statements, and appeals to the public are overdone, and sadly lacking in psychological skill. A certain crankiness, with strange combinations of rashness and caution, stupidity and cunning, strongly suggests that inebriate intellects are the guiding spirits in the management of these cures.

On the other hand, the very spirit and hurry of the movement suggest a full recognition of the brevity of the work and the need of active labor before the "night cometh when no man can work." In this the highest commercial and psychological skill appears. Dependence for popularity of the cure on the emotional enthusiasm of reformed inebriates also suggests a short life and early oblivion, of which every temperance and church movement for this end furnishes many illustrations.

There can be no doubt of the fact that a certain number of inebriates are restored by each and all these various methods of cure, and a certain other number, always in the great majority, are made worse and more incurable and degenerate by the failures of such means. But, above the mere curing of a certain number of cases, a great psychological movement is stimulated, and a wider conception of the evil follows of permanent value. The inebriety specifics are epidemics of empiricism that will pass away soon, but they will rouse public sentiment and bring out the facts more prominently as to the disease of inebriety and its curability. This second stage of this truth resembles the "squatter period" of every new Territory—a stage of occupation by squatters, fortune-hunters, and irregulars of every description, who rouse great expectations, build canvas towns, making a show of permanent settlement, and attract crowds of credulous followers, only to prey on them. These persons always disappear when the real settlers come. They never develop any lands or discover any new resources, but prepare the way and concentrate public attention for the final occupation. The specific vaunter of to-day is the squatter settler, who will soon disappear, and be followed by the real settler and the scientists.

Inebriety, its causes and possible remedies, are a vast, unknown territory, the boundary lines of which have been scarcely crossed. The facts are so numerous and complex, and governed by conditions that are so largely unknown, that dogmatism is ignorance and positive assertions childishness.

The recognition of disease is only recently confirmed by the accumulation of scientific facts, although asserted and defended for a thousand years as a theory. The realm of causation is still invested with moral theories, and moral remedies have been used in the same way for a thousand years. While science has pointed out a few facts and possible laws of causation, and indicated certain general lines of treatment, it gives no support to the possibility of any specific remedy that will act on an unknown condition in some unknown way. Inebriety is literally an insanity of the border-line type, and a general condition of central brain defect, unknown, and at present beyond the power of any combination of drugs. To the scientists, all this confusion of theory and empiricism hides the real movement, and is in itself unmistakable evidence that somewhere in the future the entire subject will be known, not as a statement or theory, but as scientific truths established on scientific evidence beyond all doubt.

The specific epidemic delusions for the cure of inebriety will quickly disappear, as others have done before, and its real value to science and the world will appear from future psychological studies.

THE EVOLUTION OF DANCING.

By LEE J. VANCE.

IN his Descent of Man, Mr. Darwin refers briefly to the queer antics and dancing performances of birds during the excitements of courtship. He shows that such actions are made by the male to charm the female. The plain inference is that from the amatory feelings arises not love-dance only, but dancing in general.

Now, I think Mr. Spencer would say that the relation between courtship and dancing is not a relation of cause and effect; that the two are simultaneous results of the same cause—namely, overflow of animal spirits and vivacity of every kind. The spirit that moves men to shuffle their feet, kick up their heels, even to gambol madly until they swoon from exhaustion, may come from different feelings: now from youth, health, and exuberant spirits, and now from joy or triumph, defiance and rage.

> "On with the dance! Let joy be unconfined;
> No sleep till morn, when youth and pleasure meet."

In brief, dances as representations of love-making are not frequent among the lower races, while mystic, festive, and erotic dances are numerous enough. Only among the more advanced races, as the semi-civilized peoples of Asia and among the European peasantry, do we read of love-dances, and, oddly enough, these are performed usually by women, not by men.

Dancing, as an art, has been of gradual growth, and subject to the law of evolution. Wild, irregular, and fantastic dancing performances take after a while more regular and more artistic forms. Thus, we are able to show how savage dances, as of the Australians, develop into barbarous dances, as of the American Indians, while these in turn are modified, or perhaps improved, by more advanced peoples, as the Egyptians; how, again, in the early dances of Greece, in the Greek *mysteries*, there are survivals of the "mad doings," as Plutarch calls them, of savage races.

Folk-dancing was the first to rise into finished art. It has been rightly called "the eldest of the arts," just as music is the youngest. Beginning as a desire to kick, dancing grows into pantomime, which expresses a thought. As an art factor folk-dance can not be overrated. Out of the old rural songs and the local cultus dances—known as mysteries and religious festivals—the marvelous structure of Greek drama was evolved. Dionysus, the god of orgies, of wine, of Bacchic revel, became in course of time the patron of the drama. Indeed, several of the great dramatists, as Æschylus and Sophocles, were clever and skillful dancers, who led in the chorus. They introduced the traditional dances

Fig. 1.—An Iroquois Dancer in Costume, with Mask, Staff, and Turtle-shell Rattle.

in their plays for an artistic purpose; while the songs that were sung to the accompaniment of the dance took a more formal shape in that kind of poetry known as the ballad.

For the purposes of this discussion, folk-dancing may be divided into three classes: First, we have social dances. They are for pleasure or amusement, sometimes comic and sometimes erotic. In the second class let us place war-dances. They are expressions of defiance or rage, and they survived in the military dances of the Greeks and Romans. Thirdly, we have religious dances of various kinds. They are arranged usually by "medicine-men" or priests; they are magical in character, and are connected with some rite or superstition. The savage invariably confounds dancing with religion. His most elaborate dances are associated with mystery-plays, setting forth in action the story of some traditional event or some deity. The leaders of the revels are medicine-men or chiefs.

Now, it is a matter of common report that uncivilized people spend half their time in dancing. Thus, we read that the chief occupation of the Indians of southern California used to be dancing when the men were not engaged in procuring food.* The Spaniards have been noted for their saltatory expertness, and yet Cortes and his followers were surprised to find the art so much in favor in Mexico. The Spanish historian Herrera says that in dancing "no part of the world exceeds New Spain." He adds, "though many of those dances were performed in honor of their gods, the first institution of them was for the diversion of the people, and therefore they learned the same from their childhood and were singularly exact." †

Aside from the speculation as to "the institution" of dancing, the phrase "singularly exact" is here worthy of some notice; for it is a mistake to suppose that the savage dances hap-hazard, without any rule of action. On the contrary, the "medicine-dances" of the Indians are danced in a certain, definite way. Whether it be for rain, for green corn, or for success in the chase, the dancer follows the steps and paces fixed and regulated by tradition or custom.

Let me observe that mystic dance is a serious business. It behooves the dancer to be "singularly exact" when a *faux pas* would result in his death. This point is very strongly put by Dr. Franz Boas, who studied the dances of the coast tribes of British Columbia. Among the Kwakiutl Indians, "any mistake made by a singer or dancer is considered opprobrious. At certain occasions *the dancer who makes a mistake is killed.*" ‡ The ancient Mexicans did not mind putting an awkward dancer out of the way, and the savage practice has been found in one or two other parts of the world.

The punishment does not seem so severe, when we consider the cruel rites and initiations a dancer must pass through, ere he knows the secrets of the order or of his tribe. The savage is great on fierce initiations. He joins this or that secret order, this or

* United States Geological Survey west of the One Hundredth Meridian, vol. vii, p. 29.

† History of America, vol. iii, p. 227. ‡ Journal of American Folk Lore, vol. i, p. 51.

that dancing society, either to show his endurance or to learn the awful revelations which may make him a priest or chief. The cruel rites begin in childhood days.* Thus, every Zuñi boy of the age of four or five has no choice about being initiated into the *kok-ko,* the principal feature of which is a brutal whipping.

Fig. 2.—Dancing Paraphernalia: Shaman's Shirt. (Front view.)

This practice reminds us of the initiations into the mysteries of Artemis, wherein Spartan boys were cruelly scourged.†

What makes early dancing sacred are cruel ceremonies which give sanction to secrecy. The more severe the initiation the more sacred is the dance. "A man who wanted to get the secrets," said Pipe Chief to George Bird Grinnell, "had to go through a severe trial, such as dancing and fasting."‡ The severe trial in the Pawnee Young Dog's Dance consisted in the candidate having his breast cut, and strings or sticks passed through the slits, which were tied to posts, and then the dancer endeavored to break loose by tearing out the skin.

Mr. Paul Beckwith describes a Dakota "medicine-dance," given in midwinter, and "one can readily imagine the agony the candidate must undergo, clothed only in a coat of paint."

* Mrs. Stevenson, in the Fifth Annual Report on Ethnology, p. 552.

† Pausanias, iii, 15.

‡ Journal of American Folk Lore, vol. iv, p. 307.

The Sioux have a "Sun-Dance," in which the dancers move their bodies from side to side, forward and backward, so as to stretch the gashes in their breasts and shoulders to the fullest extent. "To see one undergoing this fearful torture called dancing," writes Mr. Beckwith, "naked, painted black, hair streaming, blood trickling from their gashes, is a dreadful sight indeed." *

Let us next observe a remarkable feature of early dancing. There are dances that women may not see, on pain of death. So, too, the women have dances from which the men are rigorously excluded. The Aleuts, according to Mr. Dall, have mysteries sacred to the males and others to the females.† He says that "hundreds

Fig. 3.—Shaman's Shirt. (Back view.)

of women, wearing masks, danced naked in the moonlight, men being rigidly excluded, and *liable to death if detected in intruding.*" Mrs. Erminnie Smith mentions a moonlight dance by women of the Iroquois tribe. As to the exclusion of the women from secret dances of the men, and the men from dances performed in secret by women, a number of interesting instances might be added.

* Smithsonian Report, 1886, Part I, p. 250. In Harper's Weekly, December 13, 1890, there is a full-page picture of a Blackfeet brave undergoing the torture in the sun-dance. The spirited drawing was made by Mr. Frederic Remington on the spot.

† Third Ethnological Report, p. 139.

Fig. 4.—Whistles and Rattles.

The natives have stories of the awful consequences that follow if a man or woman intrudes upon a dancing party or place. The Eskimos build large houses for dancing, "which are devoted to spirits." * One evening a woman with more curiosity than prudence entered the sacred house. She touched the *tornaq*, or spirit of the house, and "all of a sudden she fell down dead." According to Mr. Derby, the Indians of the upper Xingu dance within a feast-house or "flute-house," and "any women who should venture to enter this house would die." † A rattle is used by these Indians to call the dancers together, and to warn away the women. In Brazil, some tribes make a loud noise on "jurupari pipes," which answer the same purpose. No woman is allowed to see the pipes. Again, a little instrument known to English boys as the "bull-roarer" is used in mystic dances. In Australia, the *turndun* (as the bull-roarer is there called) is never shown to women, who flee and hide themselves when the sound is heard. ‡ Wherever found, be it in Australia, in Zululand, or in New Mexico among the Zuñis, the bull-roarer is regarded with religious awe.

Fig. 5.—The Whizzer.

Another feature of these medicine-dances is the habit of daubing a candidate with clay, paint, or dirt of any kind. As to the meaning of the practice there is a difference of opinion. The daubing is meant sometimes to be weird and grotesque; sometimes totemistic, when animals, plants, and stars are represented. In the Young Dog's Dance, above mentioned, the braves were painted red over the whole body, and, among other decorations, on the pit of the stomach a black ring, which "represented themselves—their life"—so Mr. Grinnell interprets it.

Then there is the habit of wearing masks and odd costumes. Some of the masks represent the human face; others are fashioned after the totem; others, again, are nondescript. The Aleuts, says Mr. Dall, "had the usual method of dancing with masks on during the progress of the several sorts of ceremonies." # For ordi-

* Sixth Report of the Bureau of Ethnology, p. 597. † Science, Sept. 7, 1888, p. 118.

‡ It is a flat piece of wood tied to a string, and, when whirled around, causes a peculiar muffled roar. Kamilaroi, etc., by Howitt, p. 268.

Third Report of the Bureau of Ethnology, pp. 138, 141.

nary dances the masks are "excellent representations of the Aleutian type of face." In the New Hebrides group of islands, "masks are used in dances which the women are prohibited from

FIG. 6.—AGRICULTURAL DANCE.

seeing."* Now, just as with the bull-roarer, so it is with masks used in secret dances—the women are forbidden to see them.

We now pass to dances of people in the agricultural stage. They are performed for rain, for the fertility of the land, for bountiful harvests, and in honor of the deities that preside over

* Third Report of the Bureau of Ethnology, p. 141.

the department of agriculture. As a rule, dances appropriate to seedtime and harvest are partly secret, partly public. At one time or another the whole people participate in the festivities. Among the Seminole Indians, the Rev. Clay MacCauley informs us, as the season for holding the "green-corn dance" approaches, the medicine-men assemble and, through their ceremonies, decide when it shall take place.* The Iroquois have also a green-corn dance—a September festival lasting three days. The "Great Feather-Dance" is performed at this time by a band of costumed dancers. It is one of the most imposing dances of the Iroquois. "The Great Feather-Dance," says Mrs. Converse, who witnessed the ceremonies in the fall of 1891, "is quite unlike the war-dance. In its performance the dancer remains erect, not assuming those warlike attitudes of rage and vengeance which plainly distinguish the two dances." †

The most elaborate dances in vogue among the Zuñi Indians are those performed to obtain rain for the growing crops. The course of the sun at the summer solstice is watched by the priest, who counts the days for the dances. Then the herald announces from the house-tops that the time for the rain-dances has arrived, and all are summoned.‡ During the summer there are eight *kor-kōk-shi*, or "good dances" for rain." A strange feature of one or two of these rain-dances is the appearance of clowns, who introduce a comic element into the sacred ceremonials.

But stranger still is the use of serpents in the medicine-dances around seed time. The striking example is that of the Moqui "Snake-Dance," an account of which fills a book.# As to the origin and significance of this wonderful dance, in which venomous snakes are carried in the hands and mouths of the performers, we do not undertake to decide. Captain Bourke says that "one of the minor objects of the snake-dance has been the perpetuation, in dramatic form, of the legend of the Moqui family." He inclines to the belief that the dance is a form of serpent-worship. On the other hand, Mr. Walter Fewkes has recently put forth the suggestion that the Moqui snake-dance "is a simple form of water ceremonial." ‖ According to his view, the snake was first introduced into the dance as a symbol of water, and the predominance given to the snake in the ceremonials is the result of later additions to the primitive ceremonial.△

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* Fifth Report of the Bureau of Ethnology, p. 522.

† Journal of American Folk Lore, vol. iv, p. 75.

‡ This summons or invitation to the harvest or agricultural dances is a common practice.

\# The Snake-dance of the Moquis. By Captain John G. Bourke.

‖ The Meaning of the Snake-dance, in Journal of American Folk Lore, vol. iv, p. 137.

△ See also Mr. Fewkes's paper, A Few Summer Ceremonials at Zuñi Pueblo. The curi-

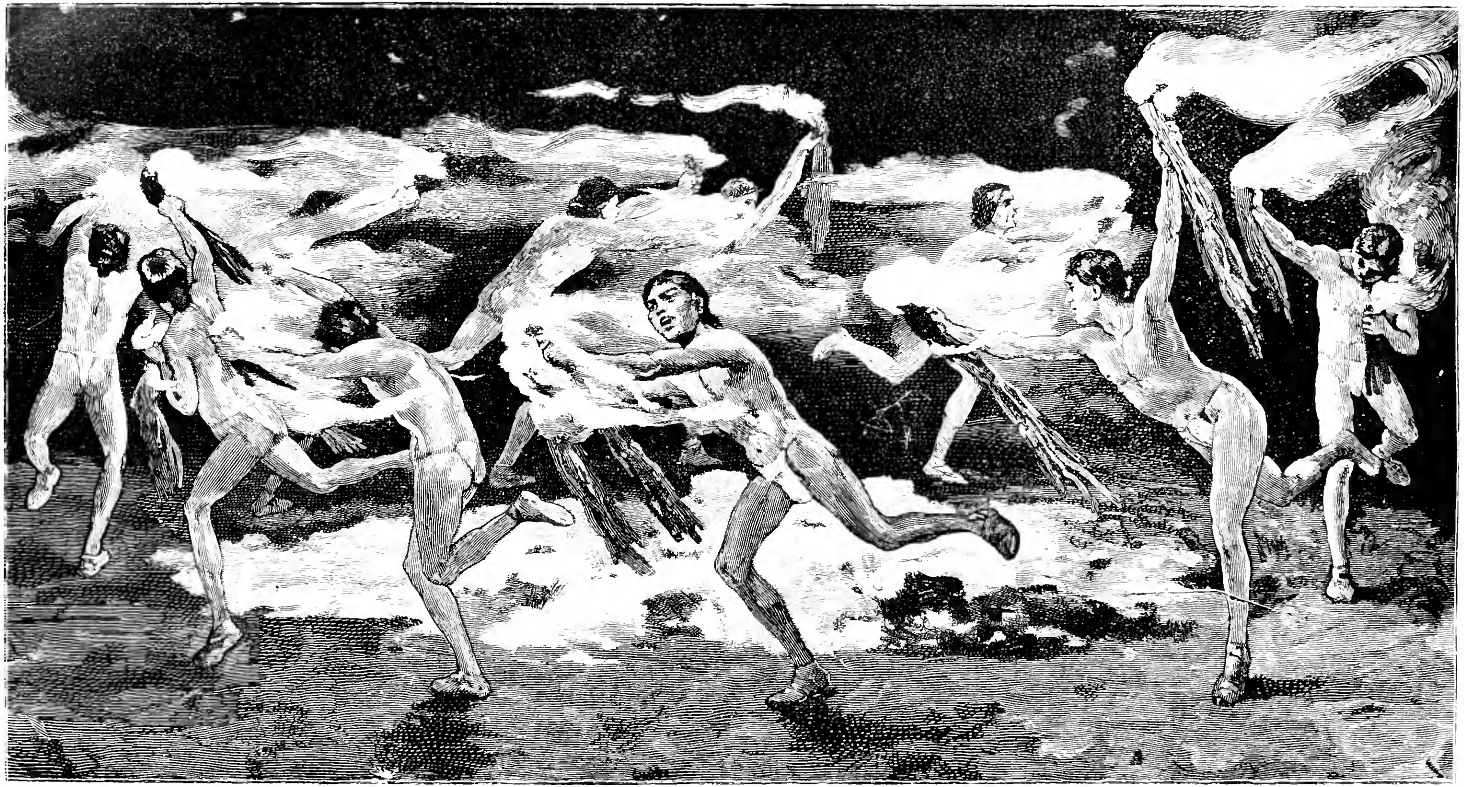

FIG. 7.—FIRE-DANCE.

It is not generally known that Pawnee, Dakota, and Zuñi rites and initiations were retained in the religious dances of ancient Greece. The use of the *conus*, or bull-roarer, the practice of daubing the candidate with clay or dirt, the wearing of masks, the use of serpents—these all are found in the Greek mysteries. It is undeniable that, in their mysteries, the Greeks danced much as the Iroquois, Kwakiutls, and Zuñis dance in their secret rites. The goddess Artemis, at Brauron, in Attica, was served by young girls, who imitated in dances the gait of bears. So, too, we have the wolf-dances of the Hirpi, in which the performers clothed themselves in the skin of the wolf whose feast they celebrated.* Even after the Greeks gathered into walled cities, mystic dances ("medicine-dances" the Indians would call them) took place in the local fanes of the tribal gods and around the ancient altars.

Take, for example, the mysteries of Demeter, "she of the harvest home," "of the corn-heaps." Two mysteries are well known to classical scholars as the Eleusinia and the Thesmophoria. In the former, after purifications, the *mystæ*, the initiate, performed wild and erotic dances, and in later days, when the Eleusinian rites became part of the state religion of Athens, there was, in conclusion, a spectacular miracle-play representing the sorrows and consolations of Demeter—the most touching, most pathetic figure in Greek mythology. The Thesmophoria was the feast of seed time. The Greek matrons performed certain sacred rites and secret dances, which the men were prohibited from seeing. Heroditus says that the Thesmophoria were brought from Egypt, where the women danced in similar fashion before the altar of the bull-god in the Memphian temples. There must have been some licentious doings in the Greek mystery, or else the plain-spoken historian would not have "omitted them by silence." His apology for concealment is neatly put: "As they refused to tell for religion, so we desired not to hear for modesty."

The important feature of all mysteries, savage or Greek, is dancing. Lucian, in his Treatise on Dancing, says: "You can not find a single ancient mystery in which there is not dancing. . . . This much all men know, that most people say of the revealers of the mysteries that they 'dance them out.'" Mr. Andrew Lang, who has made a close study of Greek mysteries, quotes the reply of Quing, the Bushman, who was asked about some myths of his people. Quing replied: "Only the initiated men of that dance know these things." Hence to "dance out" this or that, observes Mr. Lang, means to be acquainted with this

ous masks and customs are represented by photographs; the music was taken with the phonograph.

* Aristophanes, Lysistratra, 646.

FIG. 8.—DANCE OF NAHIKAI.

or that myth, which is represented in a dance or *ballet d'action*.* This brings us to the point we would be at. The medicine-dances develop into mystery plays, setting forth this or that myth, which in turn reached artistic development in the old Greek drama.

The most striking example of barbaric drama is that of "The Mountain Chant" of the Navajo Indians. The ceremonial, lasting nine days, presents in a dance or series of dances a myth of tribal history, beginning at a time when the Navajo became a distinct people.† The significance of the "chant" has been stated concisely by Major J. W. Powell: "This ceremony dramatizes the myth with rigorously prescribed paraphernalia and formularies, with picturesque dances and shows, scenic effects, and skillful thaumaturgic jugglery. It is noticeable also that here the true *popular drama is found in the actual process of evolution from religious mysteries or miracle plays*. . . . It is to be remarked that the Shaman has become the professional and paid artist and stage manager, under whom is gathered a traveling corps of histrions and scenic experts." ‡

Here is the proper place to observe that dancing has a bearing on the development of the social order. The medicine-men or priests gain and retain political and social powers through their skill in leading the dance. According to Mr. Beckwith, "the high priest in the religious ceremonies of the Dakotas is *invariably a chief* who, through these dances, retains his influence in the tribe." # Thus, dancing gives sanction to the powers of the chief, and is one of the necessary qualifications for the office. It is thus associated with position and rank. In the Vedic age (2000 B. C.), before the rigid division of castes, the priests were leaders of the dance at the festivals. ‖ Later on they became all-powerful Brahmans. The Homeric chiefs were distinguished dancers. Lucian says that Troy was taken, Zeus was saved, and Ariadne ruined by a dance. And David led the dance before the ark. The ancients regarded dancing as a necessary accomplishment. Socrates learned the art in his old age; while Plato, in his Commonwealth, advocated the establishment of dancing schools. The Romans celebrated their victories and pastoral festivals by elaborate dances. They excelled in pantomime dances, from which the ballet was evolved.△ The Emperor Domitian forbade

* Custom and Myth, p. 42.

† A description of the ceremonies, together with sketches, has been furnished by Dr. Washington Matthews (Fifth Report Ethnology, pp. 385–468).

‡ Fifth Report of the Bureau of Ethnology, p. xlvi.

Smithsonian Report, 1886, Part I, p. 245.

‖ Weber, p. 37.

△ Until early in the seventeenth century the performers in the ballet were men.

the senators to dance, and for so doing removed several members from the senate. Grave statesmen and politicians of high degree

Fig. 9.—Dancing Dervishes.

have excelled in the eldest of the arts. Both Sully and Cardinal Richelieu were expert dancers. Think of the august cardinal paying his court to Anne of Austria, by performing a saraband before her in jester's dress of green velvet, with bells on his feet and castanets in his hands! *

Long after dancing became secularized, it remained part and parcel of divine services. Gregory Thaumaturgus introduced prancing into Christian ritual; and Scaliger derives *præsules*—a name given to the bishops—from *a præsiliendo*, from the fact of their "skipping first," or leading the clergy, in the altar-dances. In the middle ages the Mystery Plays were simply choral dances and songs. There were biblical stories and "moral lessons" told to the folk. The famous Dance of Death was a popular spectacular play, in which pope, cardinal, king, prince, and pauper were invited by the gay and festive skeleton to dance with him, and there was no alternative. Finally, as a survival from the mediæval Church, we have the Corpus Christi dances, which were performed until within late years by the congregation in the Seville Cathedral.†

The orgiastic impulse is one of the wildest and most rebellious passions in human nature. It is continually breaking through the thin veneer that civilization supplies. It has shown itself at different times in Europe.‡ This "passion of Dionysus" takes possession of the folk, of the people in the country, on heath or by sea. The impulse which seizes girls in modern Greece is so strong that they dance themselves to death on the hills. The dancers are victims of the Nereids, say the peasants. In ancient Greece, as Mr. Lang observes, they would have been saluted as the nurses and companions of Dionysus, and their disease would have been hallowed by religion.#

It needed only a young Cheyenne to fall into a trance, to dream that he had seen and talked with the Christ, to proclaim himself a prophet of the new religion, to begin dancing in fast and furious fashion—it needed only this to start the "Messiah craze" in the fall of 1890.‖ The dancing mania soon seized the Indians, and, within a month, the Cheyennes, Pawnees, Comanches, Arapahoes, Kiowas, Wichitas, and other smaller tribes were performing the "dance to Christ," called by the whites the "Ghost-

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* In the days of Queen Bess—the queen herself an adept in the art—"the grave Lord Keeper led the brawls," without losing his own respect and dignity.

† In the *autos sacramentales*, or miracle plays, dancing was introduced in honor of the sacrament. The little choir boys of the cathedral still dance before the Host every evening at five o'clock.

‡ See Lecky's Rationalism in Europe, vol. i, p. 77, for the "dancing mania" of Flanders and Germany.

Myth, Ritual, and Religion, vol. ii, p. 241.

‖ Miss Alice Fletcher says the "craze" would have died out had it not been for the medicine-men or conjurers, who "multiplied stories and marvels."—*Journal of American Folk Lore*, vol. iv, p. 60.

Dance." "They will dance," says one witness, "from Friday afternoon till sundown on Sunday. They keep going round in one direction until they become so dizzy that they can scarcely stand, then turn and go in the other direction, and keep it up until they swoon from exhaustion. That is what they strive to do, for while they are in a swoon they think they see and talk with the new Christ." Now, observe: "At the end of the dance they have a grand feast, the revel lasting all Sunday night." *

Thus far little has been said about the different movements and steps of ancient dances. What the figures "woven paces and waving hands" in early Greek dances were, no one can say with exactness. The earliest description of dancing which we can reproduce is the account of the dance on the shield of Achilles, which bore the sculptured scene

> "Of youths and maidens bounding hand in hand.
> . . . .
> Now all at once they rise, at once descend,
> With well-taught feet; now shape in oblique ways
> Confus'dly regular the moving maze;
> Now forth at once, too swift for sight, they spring,
> And undistinguished blend the flying ring:
> So whirls a wheel in giddy circle tost,
> And rapid as it runs the single spokes are lost."

Here we have the simplest kind of dancing. Youths and maidens take one another by the hand, and spin round and round like a potter's wheel. This form of Homeric Greek dance in the dance of Bacchus is known as the dithyramb. It survives to the present day in the "jiggering" of children, who join hands and prance around in a circle.

Later on, the Greeks divided dances into round and square. Their round dances—the word "round" meaning something more than our "round"—were dances of pleasure and revelry. Their square dances were military and dramatic. The Spartans drilled their men in Pyrrhic dance to the ringing sound of spear and shield. The square dances of the ancients required some art and some practice, while little of either was necessary in their round dances.

The real charm of true dancing consists rather in a graceful swaying of the body and arms than in violent movements and complicated steps. Take, for example, the dances performed by the Nautch girls—the most enchanting and ravishing dancers in the world. In their dances you see no springs, no vehement *pirouettes*, no violent sawing of the arms, no painful contortions

* Journal of American Folk Lore, March, 1891.

of the limbs, no bringing of the legs at right angles with the body as in our *ballet*, no dizzy gyrations—in short, "none of that exquisite precision of step and pedal dexterity which constitute the chief charm of European artists." * The Spanish dances—

FIG. 10.—CSARDOS, HUNGARIAN FOLK-DANCE.

which of late have become popular—are free from violent movements and intricate steps. Indeed, the feet play so small a part in the action that the dancer seems scarcely to raise them from the ground. The dances are little more than graceful writhings and twistings of the body; the arms and legs moving in sinuous folds and contortions, like the movements of a snake; the dancer all the while beating time with the castanets held in each hand.

This brings us down to the more developed or modern forms of dancing. Different people have arranged their peculiar dances. The French have devised many intricate steps; the English had their "country-dances" round the May-pole; the Scotch invented the reel; the hornpipe was originally a Cornish dance, and so on.

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* The Oriental Annual, or Scenes in India. By Rev. H. Caunter. London, 1836, p. 20, where there is a fine description of the Nautch girls in their charming dances.

Thus, we have all kinds of "national dances," so called. Oddly enough, the national dance of Hungary sets forth the drama of courtship—the shy advance, the maidenly modesty and retreat, the proposal, the rejection, but finally the open-armed acceptance. (See illustration.)

Finally, dancing follows a general law of mental evolution, namely, that practices which occupy an important place in the minds and daily doings of people in a savage stage of culture survive only as matters of amusement, or perhaps of æsthetic feeling, in a period of civilization. And such is now the place occupied by the eldest of the arts. When we regard the pavan, the gavotte, the minuet, the Sir Roger de Coverley, or the waltz, we may see in them the survivals of that primitive impulse which we often fail to recognize in camp-meetings and church "revivals."

THE NATIVE AND FOREIGN-BORN POPULATION.

VIII.—LESSONS FROM THE CENSUS.

By CARROLL D. WRIGHT, A. M.,
UNITED STATES COMMISSIONER OF LABOR.

THE native and foreign-born population of the United States has been given to the public in Census Bulletin No. 194. The designations of the foreign-born as to countries from which they came are not included in the bulletin. It is impossible, therefore, to consider any question beyond that of the distinction between native and foreign-born, with the addition of immediate parent nativity.

Native and Foreign-born Population, 1890.

States and Territories.	Total population.	Native.	Per cent of native of total population.	Foreign.	Per cent of foreign of total population.
The United States.......	62,622,250	53,372,703	85·2	9,249,547	14·8
North Atlantic Division..	17,401,545	13,513,368	77·7	3,888,177	22·3
Maine..................	661,086	582,125	88·1	78,961	11·9
New Hampshire.........	376,530	304,190	80·8	72,340	19·2
Vermont...............	332,422	288,334	86·7	44,088	13·3
Massachusetts..........	2,238,943	1,581,806	70·6	657,137	29·4
Rhode Island..........	345,506	239,201	69·2	106,305	30·8
Connecticut............	746,258	562,657	75·4	183,601	24·6
New York..............	5,997,853	4,426,803	73·8	1,571,050	26·2
New Jersey............	1,444,933	1,115,958	77·2	328,975	22·8
Pennsylvania..........	5,258,014	4,412,294	83·9	845,720	16·1

Native and Foreign-born Population, 1890.—(Continued.)

STATES AND TERRITORIES.	Total population.	Native.	Per cent of native of total population.	Foreign.	Per cent of foreign of total population.
South Atlantic Division..	8,857,920	8,649,395	97·6	208,525	2·4
Delaware	168,493	155,332	92·2	13,161	7·8
Maryland	1,042,390	948,094	91·0	94,296	9·0
District of Columbia	230,392	211,622	91·9	18,770	8·1
Virginia	1,655,980	1,637,606	98·9	18,374	1·1
West Virginia	762,794	743,911	97·5	18,883	2·5
North Carolina	1,617,947	1,614,245	99·8	3,702	0·2
South Carolina	1,151,149	1,144,879	99·5	6,270	0·5
Georgia	1,837,353	1,825,216	99·3	12,137	0·7
Florida	391,422	368,490	94·1	22,932	5·9
North Central Division..	22,362,279	18,302,165	81·8	4,060,114	18·2
Ohio	3,672,316	3,213,023	87·5	459,293	12·5
Indiana	2,192,404	2,046,199	93·3	146,205	6·7
Illinois	3,826,351	2,984,004	78·0	842,347	22·0
Michigan	2,093,889	1,550,009	74·0	543,880	26·0
Wisconsin	1,686,880	1,167,681	69·2	519,199	30·8
Minnesota	1,301,826	834,470	64·1	467,356	36·9
Iowa	1,911,896	1,587,827	83·0	324,069	17·0
Missouri	2,679,184	2,444,315	91·2	234,869	8·8
North Dakota	182,719	101,258	55·4	81,461	44·6
South Dakota	328,808	237,753	72·3	91,055	27·7
Nebraska	1,058,910	856,368	80·9	202,542	19·1
Kansas	1,427,096	1,279,258	89·6	147,838	10·4
South Central Division..	10,972,893	10,651,072	97·1	321,821	2·9
Kentucky	1,858,635	1,799,279	96·8	59,356	3·2
Tennessee	1,767,518	1,747,489	98·9	20,029	1·1
Alabama	1,513,017	1,498,240	99·0	14,777	1·0
Mississippi	1,289,600	1,281,648	99·4	7,952	0·6
Louisiana	1,118,587	1,068,840	95·6	49,747	4·4
Texas	2,235,523	2,082,567	93·2	152,956	6·8
Oklahoma	61,834	59,094	95·6	2,740	4·4
Arkansas	1,128,179	1,113,915	98·7	14,264	1·3
Western Division	3,027,613	2,256,703	74·5	770,910	25·5
Montana	132,159	89,063	67·4	43,096	32·6
Wyoming	60,705	45,792	75·4	14,913	24·6
Colorado	412,198	328,208	79·6	83,990	20·4
New Mexico	153,593	142,334	92·7	11,259	7·3
Arizona	59,620	40,825	68·5	18,795	31·5
Utah	207,905	154,841	74·5	53,064	25·5
Nevada	45,761	31,055	67·9	14,706	32·1
Idaho	84,385	66,929	79·3	17,456	20·7
Washington	349,390	259,385	74·2	90,005	25·8
Oregon	313,767	256,450	81·7	57,317	18·3
California	1,208,130	841,821	69·7	366,309	30·3

The historian Bancroft stated that in 1775 the colonies were inhabited by persons "one fifth of whom had for their mother-tongue some other language than the English." The French, the Swedes, the Dutch, and the Germans contributed this one fifth, and in the order named. In 1890 the total foreign population numbered 9,249,547, while the total number having foreign-born parents, but who themselves were born in this country, was 11,503,675, making a total of foreign-born and children of foreign-born parents of 20,753,222—that is, one third of the total population of the United States consists of people born in foreign coun-

Native and Foreign-born Population, 1880.

States and Territories.	Total population.	Native-born population.	Foreign-born population.	Per cent of native-born of total population.	Per cent of foreign-born of total population.
Alabama	1,262,505	1,252,771	9,734	99·23	0·77
Arizona	40,440	24,391	16,049	60·31	39·69
Arkansas	802,525	792,175	10,350	98·71	1·29
California	864,694	571,820	292,874	66·13	33·87
Colorado	194,327	154,537	39,790	79·52	20·48
Connecticut	622,700	492,708	129,992	79·12	20·88
Dakota	135,177	83,382	51,795	61·68	38·32
Delaware	146,608	137,140	9,468	93·54	6·46
District of Columbia	177,624	160,502	17,122	90·36	9·64
Florida	269,493	259,584	9,909	96·32	3·68
Georgia	1,542,180	1,531,616	10,564	99·31	0·69
Idaho	32,610	22,636	9,974	69·41	30·59
Illinois	3,077,871	2,494,295	583,576	81·04	18·96
Indiana	1,978,301	1,834,123	144,178	92·71	7·29
Iowa	1,624,615	1,362,965	261,650	83·89	16·11
Kansas	996,096	886,010	110,086	88·95	11·05
Kentucky	1,648,690	1,589,173	59,517	96·39	3·61
Louisiana	939,946	885,800	54,146	94·24	5·76
Maine	648,936	590,053	58,883	90·93	9·07
Maryland	934,943	852,137	82,806	91·14	8·86
Massachusetts	1,783,085	1,339,594	443,491	75·13	24·87
Michigan	1,636,937	1,248,429	388,508	76·27	23·73
Minnesota	780,773	513,097	267,676	65·72	34·28
Mississippi	1,131,597	1,122,388	9,209	99·19	0·81
Missouri	2,168,380	1,956,802	211,578	90·24	9·76
Montana	39,159	27,638	11,521	70·58	29·42
Nebraska	452,402	354,988	97,414	78·47	21·53
Nevada	62,266	36,613	25,653	58·80	41·20
New Hampshire	346,991	300,697	46,294	86·66	13·34
New Jersey	1,131,116	909,416	221,700	80·40	19·60
New Mexico	119,565	111,514	8,051	93·27	6·73
New York	5,082,871	3,871,492	1,211,379	76·17	23·83
North Carolina	1,399,750	1,396,008	3,742	99·73	0·27
Ohio	3,198,062	2,803,119	394,943	87·65	12·35
Oregon	174,768	144,265	30,503	82·55	17·45
Pennsylvania	4,282,891	3,695,062	587,829	86·27	13·73
Rhode Island	276,531	202,538	73,993	73·24	26·76
South Carolina	995,577	987,891	7,686	99·23	0·77
Tennessee	1,542,359	1,525,657	16,702	98·92	1·08
Texas	1,591,749	1,477,133	114,616	92·80	7·20
Utah	143,963	99,969	43,994	69·44	30·56
Vermont	332,286	291,327	40,959	87·67	12·33
Virginia	1,512,565	1,497,869	14,696	99·03	0·97
Washington	75,116	59,313	15,803	78·96	21·04
West Virginia	618,457	600,192	18,265	97·05	2·95
Wisconsin	1,315,497	910,072	405,425	69·18	30·82
Wyoming	20,789	14,939	5,850	71·86	28·14
United States	50,155,783	43,475,840	6,679,943	86·68	13·32

tries or the children of people so born. It is impossible to go further back than one generation in this calculation; but in all probability, when the facts are known, we shall find that at least one half of the inhabitants of this country at the present time were either born abroad or are the children or grandchildren of persons born abroad, while one third, instead of one fifth, have for their mother-tongue some other language than the English. Future bulletins will enable us to understand this feature of the nativity of the population more clearly.

The first of the preceding tables has been constructed from those given in the bulletin named; which, however, did not give the percentages stated. It shows the total population in the United States, June 1, 1890, separated as to native and foreign-born, and the percentage of each of the total population; the second table gives like facts for 1880. (In the first table I have followed the form now in use at the Census Office, giving the States by divisions; while in the second table, for 1880, the States are alphabetically arranged.)

The State having the greatest proportion of foreign-born is North Dakota, where that element constitutes 44·6 per cent of the total population. In 1880 the State having the highest percentage of foreign-born was Nevada, it being then 41·2. Nevada now has 32·1 per cent. The State having the lowest percentage in 1880 was North Carolina, it then being ·27 per cent, and North Carolina still has the lowest percentage of foreign-born, it being but ·2 of 1 per cent in 1890. Of the population of the whole country 14·8 per cent are foreign-born. The facts are given for the different census years in the adjoining table.

Census Years.	Aggregate Population.			Native-born.			Foreign-born.		
	Total.	Increase.		Total.	Increase.		Total.	Increase.	
		Number.	Per cent.		Number.	Per cent.		Number.	Per cent.
The United States:									
1890	62,622,250	12,466,467	24·86	53,372,703	9,896,863	22·76	9,249,547	2,569,604	38·47
1880	50,155,783	11,597,412	30·08	43,475,840	10,484,698	31·78	6,679,943	1,112,714	19·99
1870	38,558,371	7,115,050	22·63	32,991,142	5,686,518	20·83	5,567,229	1,428,532	34·52
1860	31,443,321	8,251,445	35·58	27,304,624	6,357,350	30·35	4,138,697	1,894,095	84·38
1850	23,191,876	*a*6,122,423	35·87	20,947,274	....	......	2,244,602	....	......

From this short table we see the changes that are going on. Taking the last census decade of years, we find that the aggregate population increased 24·86 per cent. Analyzing this, it is seen that the native-born population increased 22·76 per cent and the foreign-born 38·47 per cent. The heaviest increase in the foreign-born was between 1850 and 1860, when it was 84·38 per cent. This was soon after the great tide of immigration set in toward this country. The highest percentage of increase in the native-born population was between 1870 and 1880, so far as the decades in the table are shown, it then being 31·78 per cent. The percentage of the native and foreign-born of the total population is given in the following tabular statement:

Census Years.	Native and Foreign-born.	
	Native.	Foreign.
The United States:	Per cent.	Per cent.
1890	85·23	14·77
1880	86·68	13·32
1870	85·56	14·44
1860	86·84	13·16
1850	90·32	9·68

This little table answers very fully the question as to whether the foreign-born are increasing out of proportion to the increase of population. Leaving out 1850, as immigration had just then begun to be felt strongly, and commencing with the decade of 1860, the percentages are very interesting. In that year the foreign-born constituted 13·16 per cent of the total population of the country. In 1890 it constituted 14·77 per cent, or an increase of ·61 of 1 per cent in the thirty years, certainly not a very alarming figure. In 1870 the foreign-born population constituted 14·44 per cent, while in 1890 it was, as stated, 14·77 per cent, an increase in percentage of ·33 per cent in twenty years. The native population in 1860 was represented by 86·84 per cent of the total population, and in 1890 by 85·23 per cent.

If we examine particular sections of the country, however, we find some extraordinary proportions. Massachusetts, for instance, in 1880 had 443,491 foreign-born persons as part of her population. This was 24·87 per cent of the total population. In June, 1890, her foreign-born population numbered 657,137, and was 29·04 per cent of the total. The foreign-born population in Rhode Island increased from 78,993 in 1880 to 106,305 in 1890. The great State of New York had 1,211,379 foreign-born persons in her borders in 1880, while in 1890 this body had increased to 1,571,050. Pennsylvania showed like proportions. In Wisconsin the foreign-born population increased from 405,425 in 1880 to 519,-

199 in 1890, but the percentage in relation to the total population did not increase. In fact, in some of the Western States, where the percentage of foreign-born population of the total population in 1880 was very high, it is found to be lower now. This is because the increase in population comes to some extent from the children of the foreign-born, who figured as such in 1880. When the full results as to parent nativity are ascertainable, the comparison as to changes and the relative proportion of the foreign-born element as such in different localities can be clearly brought out, as stated.

The total native population of the country is 53,372,703, while the total foreign-born population is 9,249,547. This latter figure represents the total number of foreign-born living persons out of the total foreign immigration during the history of the country. Prior to 1819 the Government took no account of the number of immigrants, but the accepted estimate gives the total number between 1790 and 1819 at 250,000. In 1819 the Federal Government took account of immigration, and the reports have been very regular since then. The total immigration from 1819 to 1890 was 15,686,158. On June 1, 1890, therefore, there were living, of this total number of immigrants, 9,249,547. The reports of the Treasury Department furnish the information as to the character of this body of immigrants. Future reports of the Census Office will furnish information relative to the character of the living foreign-born, not only as to the countries furnishing foreign-born population, but all the other social facts relating thereto gathered by the census. A complete analysis, therefore, must be reserved for future publications of the Census Office. But, looking at the primary facts as furnished by the Treasury Department, it is learned that, of the 15,686,158 immigrants who have settled in this country since 1820, 3,503,227 came from Ireland and 4,546,800 from Germany, including Prussia. Adding these two numbers together, we find that Ireland and Germany have furnished 8,050,027 out of the total number of immigrants, or more than 51 per cent of that total. The number coming from Germany is one million, in round numbers, greater than the number coming from Ireland.

A study of the nationalities represented in the immigration to this country shows that a little more than 50 per cent of the whole number have come from Protestant countries, and if we should look closely into the matter we should find that the two great political parties in the United States absorb equal proportions of the total volume of immigration. In a theological and political sense, therefore, immigration has been quite equally divided.

When we look at industrial conditions, however, it is learned that the absorption of immigrants has not been equal. The facts in this respect can not be given for 1890, but for 1880 they indicate what may be expected when the full facts for 1890 are reported. In 1880 the whole number of people engaged in agriculture was 7,670,493. Of this number 812,829 persons were of foreign birth; that is to say, 10·06 per cent of the whole number employed in agriculture in 1880 were foreign-born. The total number employed in manufacturing, mechanical, and mining industries in the United States in 1880 was 3,837,112. Of this number 1,225,787 were of foreign birth, and this number is 32 per cent of the whole number of persons engaged in these industries. The tendency, therefore, of our immigrants is to assimilate with our mechanical industries. This increases the supply of labor in comparison to the demand, and may in some localities tend to lower wages, and sometimes to cripple the consuming power of the whole body of the people. In 1880 12·52 per cent of the whole number of foreign-born persons were engaged in agriculture, while 18·88 per cent of the foreign-born were engaged in manufactures.

MUD AS A BUILDING MATERIAL.

By WILLIAM SIMPSON, R.I., M.R.A.S.

IT is necessary to premise that under the term "mud" I include sun-dried bricks. When bricks have been burned in the fire, the material becomes entirely changed and ceases to be mud, so I exclude them from consideration in the present paper as a building material. Wet earth made into blocks and dried in the sun differs in no way from a layer of the same laid on a wall.* Both methods were used in the East, and often combined in the same building. The reason for this is soon found out if you attempt to raise a mud wall. A layer of two or three feet thick must be allowed to dry and consolidate before another is placed on it, because the weight above would press out the soft material below, and the whole would tumble down. In some localities a layer of mud is put down at the commencement, and while that is drying bricks are made to be placed above.

It was during the cold season of 1884–'85, in traveling through Persia at the time of the Afghan Boundary Commission, that the

* Bricks of this kind, "when placed one upon another after being imperfectly dried, combined, under the influence of the weather and their own weight, into one homogeneous mass, so that the separate courses became undistinguishable. This latter fact has been frequently noticed in Assyria, by those who had to cut through the thickness of walls in the process of excavation."—Perrot and Chipiez, A History of Art in Ancient Egypt, vol. i, p. 113.

importance of mud in connection with building and architecture first attracted my attention. I had to pass from Tehran eastward, through Khorassan and into Afghan Turkestan. Along the whole of this route mud is the building material. Some of the serais—that is, caravan serais for the accommodation of travelers—are of burned brick, but these are about the only exceptions. Not only villages, but large towns, are built of mud or sun-dried brick. The defensive walls are of the same material; even such large towns as Sabzawar, Nishapur, Meshed, and New Sarrakhs are fortified with walls of this kind. On realizing this almost exclusive use of one building material, in one region, my mind naturally recalled what I had seen in India, where, although stone and fire-

Fig. 1.—The Meshed Gate, New Sarrakhs, on the Heri Rud.

burned brick are largely used, yet the villages are over very large districts wholly constructed of mud. In Afghanistan it is the same. The fort at Peshawer, which was Afghan territory up to Runjit Singh's time, is a mud one. Jellalabad is surrounded by a mud wall. From the Khyber Pass to Tehran the towns and their defenses, as well as the villages, are almost identical in their material as well as in their general appearance.

These statements show that over a large geographical space in the Eastern world the building material at the present day is almost exclusively mud. I have been thus far speaking of what I have seen with my own eyes. To this may be added the practice of other countries. I believe that it is the same over most of Central Asia. It is now accepted that in Mesopotamia it was largely employed; and we know that in Egypt, from the earliest times to the present day, it has been the principal means employed in structural erections. It was largely used in Greece in ancient times, and also in Spain. It was known in South America and all along the Pacific coast, from Peru to San Francisco. The word "dobies," for sun-dried bricks, is a familiar term—this is derived from the Spanish word *adobes*.* In 1873 I visited the original church dedicated to St. Francis, which gave its name to the now well-known town in California—this church was constructed with "dobies." Mud houses were not uncommon in England in the past, and they are yet known in Devonshire, where the stuff they are constructed with is called "cob." I am under the impression that the importance of mud in connection with building has hitherto been overlooked.

Once begun, the progress of mud architecture would be considerable. Those who began their architectural style with branches of trees could not have made any advance until some kind of implement was invented by means of which the wood could be cut and fashioned; and the "stone age," when stone tools came into use, is a comparatively late one in man's history. The mud builder, on the contrary, required no tools; his hands were sufficient for every purpose. He may have been content at first with an inclosure formed by four walls. A covering of grass or reeds would soon suggest itself; this, although rude and primitive, would be the first complete human habitation. But, more than that, it would be the beginning of the "house"—the "home," which, from the relations and associations it produced, must have been one of the most important steps in the history of early civilization.

The great antiquity of the use of mud as a building material can be established from a number of references to history. In Persia, at least, we have traces of it. Firdusi, in the Shah Namah, relates how Jemshid, now known as a mythical personage, introduced a better civilization among the people; among the improvements it is told how "he taught the unholy demon train to mingle water and clay, with which, formed into bricks, the walls were built, and then high turrets, towers, and balconies, and roofs, to keep out rain, and cold, and sunshine." It is naturally inferred that the bricks made by the children of Israel in Egypt were sun-dried from the use of the straw in them. The making of bricks is often represented in the sculptures of Egypt.

The first use or invention of mud for building was ascribed to mythical personages, thus attributing to it a kind of divine origin.

I shall now give a few details of the manner of building in mud, most of which are derived from what I saw in Persia. Many of the methods I saw there I have since found are also practiced in other parts of the world.

It was pointed out to me that, in the larger towns, on entering a house, you have often to descend from the level of the street to

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* *Adobes*, or *dobies*, is probably a variant of the Arabic *tob* or *toob*, allied again to the Coptic *tobi*, which was also the Egyptian word for brick.

the ground-floor. It was explained that this results from utilizing the earth on which the house stands, thus saving the expense of transporting the building material from outside the town.

In good houses a foundation is laid, varying from two to four feet in depth, formed of rough stones or broken fire-burned bricks, and piled up with mud and lime. This is carried up a foot or so above the ground, before the mud wall is commenced. In villages, where everything is rude, this foundation is made of any kind of rubbish that is found handy. This is a very interesting feature of mud architecture. Its object is no doubt to give strength where the wall would be liable to friction from the street traffic; and probably to prevent to a certain extent damp from rising. It would also be a safeguard against another serious danger—that is, if water were to accumulute by any chance round the base of the mud walls, and remain long enough to soak through, a very serious catastrophe might take place from the house tumbling

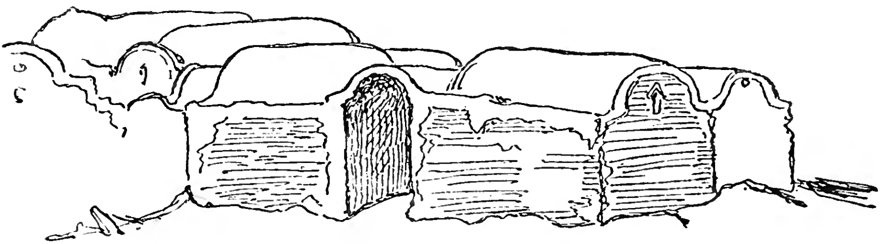

Fig. 2.—Mud-built Houses, Village of Sivah, Khorassan.

down. I can not recall to my memory any foundation of this kind in the mud houses of India. Village houses in the north-west of that country are usually built on a *chabootra*, which is a raised platform of mud, about a couple of feet in height, and this forms the floor of the house. This platform, by raising the foundation of the walls above the ground, may perhaps serve some of the purposes of the layer of stones in the Persian foundations.

The walls of Persian houses vary from two to four feet in thickness. This depends entirely on the quality of the house and the means of the builder. Thick walls make a cool house, and that is a desirable thing in the climate of Persia. If upper rooms are required, a greater strength of wall will be necessary. The mud is either laid on in layers or in the form of bricks.* In garden walls hollow bricks are used for the top, to give lightness. These bricks are called *sanduk*, a word meaning "box," which is de-

* Sun-dried bricks are called *khest* in Persian; the fire-baked bricks are *ajur* or *aujur*. In Afghanistan, *khist* is used for both burned and unburned bricks. *Gill*, with a hard *g*, is Persian for mud.

scriptive of their character.* The tendency in mud-building to produce thickness below in the walls, and lightness above, is most marked in the walls of villages and towns. These are all built with a visible batter. The earth taken out to form the ditch gives an abundant supply of material for a town wall, and a thick, solid mass at the base is necessary to give strength to the defense.

Where wood is plentiful, as in the province of Mazenderan, flat roofs are the rule. In large districts of Persia wood is scarce.

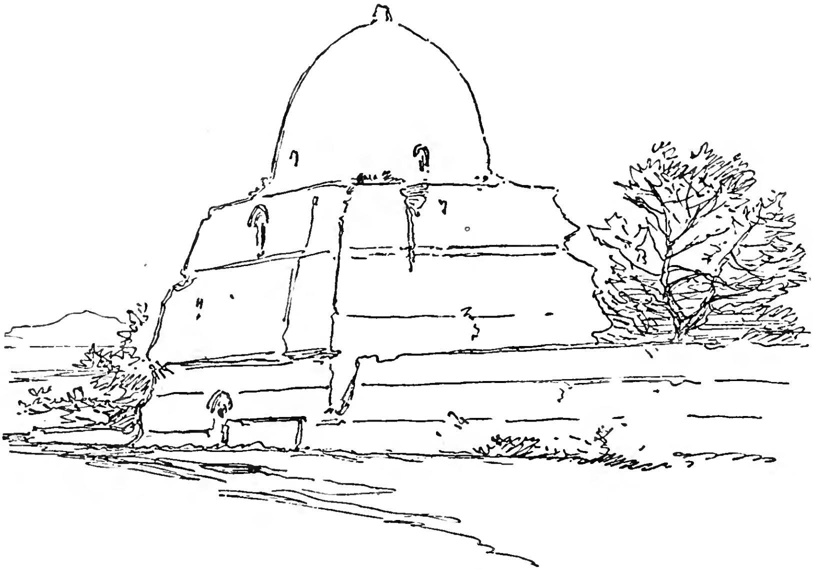

Fig. 3.—Tomb, constructed of Mud, with Dome.

I understand that south of Tehran there is very little timber, and there is also great danger from the white ants, so the vault or barrel roof is the usual means employed. According to Strabo, it was the same in Mesopotamia; he says, "All the houses are vaulted on account of the want of timber." These vaulted roofs were frequent enough along the route I traveled. I have seen whole villages with them. Square buildings would have a dome; and a semi-dome at one end of a barrel-roof seemed to be a favorite method in that part of Persia. What struck me with surprise was the facility with which these villagers could construct such roofs. If there was any irregularity in the plan of the house, the barrel-roof was extended or drawn in, as the case might be, to cover the space. Of course, in the villages it was all a very rough-and-ready kind of work, evidently done by no better principle

* This recalls an old practice of Eastern architects, in constructing domes with pots, thus producing a considerable reduction of weight, and consequent diminution of thrust. A well-known example of this is the dome of St. Vitale, at Ravenna.

than that of rule of thumb. I was still more surprised when I learned that these vaulted roofs were constructed without centers.

In Persia the mud walls are covered over with a mixture called *kahgill*,* which is composed of mud and chopped straw; this serves to prevent the rains from washing away the walls, as it hardens the surface. The application of this mixture is generally repeated every two years.

The general impression in most minds will no doubt be that mud-building only belonged to a rude condition of civilization, and produced houses that were little better than hovels. I have now to point out that this manner of building was developed into a highly decorative style which in itself would entitle it to a place in the history of architecture. This position, it appears to me, has been almost entirely overlooked by those who have written histories of architecture. Architectural writers always treat upon primitive wood constructions, because forms can be traced from it up to the highly developed styles of Greece, Egypt, and India. The same process can now be gone through with the primitive mud as a building material. At present my purpose is to show that it was carried to a pitch of finish and refinement that

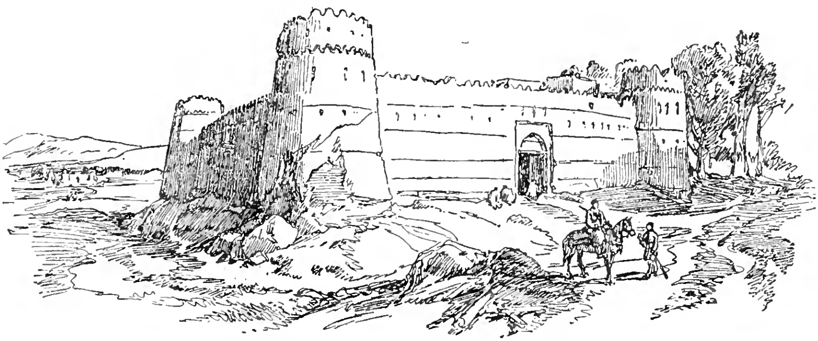

Fig. 4.—Persian Mud Village.

rendered it worthy for the palace or the temple. The following letter sent to me by General Sir Charles Wilson would in itself be a sufficient evidence. Sir Charles is well acquainted with western Asia, and, being an engineer officer, he may be trusted as an authority. He says: "It may interest to you know that in Anatolia there is much mud-building; and that most of the great buildings of the Seljuks, more especially their great palace at Konieh, were of mud faced with glazed tiles. Some of the minarets of their mosques, built with sun-dried bricks, arranged in patterns and faced with glazed tiles, or with the ends of the bricks glazed,

* The word is *kah* = straw, and *gill* = mud. In Indian villages the mud floors are washed over with a thin mixture of mud and cow-dung.

are extremely beautiful in their decay. The Seljuk architecture is Persian with a development of its own." Here are mosques, or temples, and a palace constructed with sun-dried brick, which are declared by this high authority to be beautiful even in their decayed condition.

A somewhat similar development was reached in Peru, but with different materials. Squier, in his Land of the Incas, describes the palace of Chimu, where the *adobes*, or sun-dried bricks, were covered with stucco, on which beautiful arabesques were produced in relief.* From these ornaments he calls one of the great apartments the "Hall of Arabesques";* of which he speaks in warm admiration, and adds, "No description can give an idea of the character of these *rilievos*." In describing other ornamentation of the same kind, he says, "Here, as elsewhere, there are traces of color." †

I understand that the higher developed condition of this style of architecture in Persia was attained by covering the mud walls with glazed tiles. The tiles, it must be understood, were covered with ornament.

The interior of a mud building may also be decorated with glazed tiles; but in Persia *gatch*, or gypsum, is plentiful, and where ornament is required it is much used. In an old tomb, at Sarrakhs, I saw some particularly good ornament in this material; and it appeared to me to be all hand-work. I chanced to come upon one room that impressed me with the capabilities of this manner of decoration. It was at a place called Mazinan, on the first march eastward within the Khorassan frontier. There appeared to be the remains of more than one town here; I strolled over to that which was nearest, and found that it was all formed of mud. The mass forming the mound was artificial, for I found bits of red burned bricks or vessels imbedded in it. The top was a curious maze of rooms, courts, stairs, and roofs, much of it in a tumble-down condition. The solid mass of mud or earth was about twenty feet high, and the houses were above that; still, they were not all on the same level, for I went up and down short flights of steps. The whole was of mud or sun-dried bricks. The mud must have been carefully put on at first, but the high finish was produced by *gatch*, or gypsum. There were very handsome niches all round the walls, and the fireplace had been elaborate, but some act of destruction had taken place, and the fragments lay on the floor where they had fallen. The ornament was simple; there were some slight moldings on the space between the niches. Lines had been drawn into the gypsum, and an ornament

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* Peru, or the Land of the Incas, p. 135.

† Ibid., p. 154; also at p. 411.

had been repeated by means of a stamp which had been pressed or imprinted when wet, producing a raised pattern; the impression left was so clean and perfect, it might have been gilt, and it would have been quite equal to the work we have at home on picture-frames.

Mud was the exclusive building material of that part of the world. The simple houses of the villages are formed of it; the defensive walls of the towns, which, owing to the Turkomans, were an absolute necessity to every village, were constructed of

FIG. 5.—THE MUD WALLS OF NISHAPUR, KHORASSAN.

the same. The houses of the rich were also formed with it, and it had been developed into a highly decorative style of architecture.

One would not expect much durability from such walls, yet I was informed that there are walls of sun-dried brick in Ispahan which are over three hundred or four hundred years old. This quality of durability will no doubt depend upon the character of the soil. In the northern part of Persia, according to Mr. A. Finn, of the consular service, the walls of the old city of Erig are still standing, and they are said to have existed for twelve hundred years. There still remains at Cacha, in Peru, a wall of *adobes*, or sun-dried bricks—part of the Temple of Viracocha, which was in a ruined condition about three centuries ago, when Garcilasso described it, and this wall is still standing to a height of forty feet.* There are the remains of very old walls in Egypt. There is a Devonshire saying regarding the "cob," or mud walls, of that

* Squier's Peru, p. 407.

locality, "A good hat and a good pair of shoes is all that cob wants." The pair of shoes here meant is a stone foundation such as I have described in the Persian houses—that is, to protect the lower part of the wall; and the hat is a sufficient amount of thatch, or covering, to the top of the wall to save it from the influence of rain. With such conditions, I believe that mud walls in Devon, even in our own damp climate, have stood for long periods of time.

The sloping jambs of doors and windows are peculiar to many old styles of architecture, such as the early Greek and Etruscan. Theories of origin for this have been often suggested, but we have no difficulty in accounting for them, if we suppose that the narrowness above was a form, and the natural result of the sloping walls of mud.

I have already explained how builders in mud—and which is well exemplified in Persia—construct their walls with a broad base, to give solidity below, and with a marked batter upward to reduce the weight above. It has been suggested—and, I think, with every reason in its favor—that this explains the very marked slope of the perpendicular lines of the Egyptian pylons. All the authorities agree in stating that in the old temples the outer wall forming the temenos of temples of Egypt was made of crude brick, and as the pylon was the gate through this wall in front of the temple, the great probability of its being constructed of the same material is obvious.

When I had seen village after village in Persia with vaulted or domed roofs, and learned that such roofs could be formed without centers, the idea immediately suggested itself that these methods of building had existed from the most primitive times. While the necessity for wooden centerings for building vaults and domes was believed in, we never could have credited an early state of civilization with this invention. Let this assumption regarding centers be removed, and the whole problem is changed. The earlier workers in mud or clay could not have been long in discovering how to spread their material over the space inclosed by four walls. They would, no doubt, have begun at first with small spaces, and a very little experience would soon have enabled them to deal with greater. If any one considers the matter, I think he must arrive at the conclusion that mud must have been first used for a long period of time before burned brick came into existence; and now that we know how easy it is to produce a roof with the mud, there is no great improbability in the assumption that the vault or dome, as well as the arch, all date back to a period when that material alone was in use.

I have described the foundations of a mud wall, such as they are in Persia, formed of burned bricks or stones and lime; and also

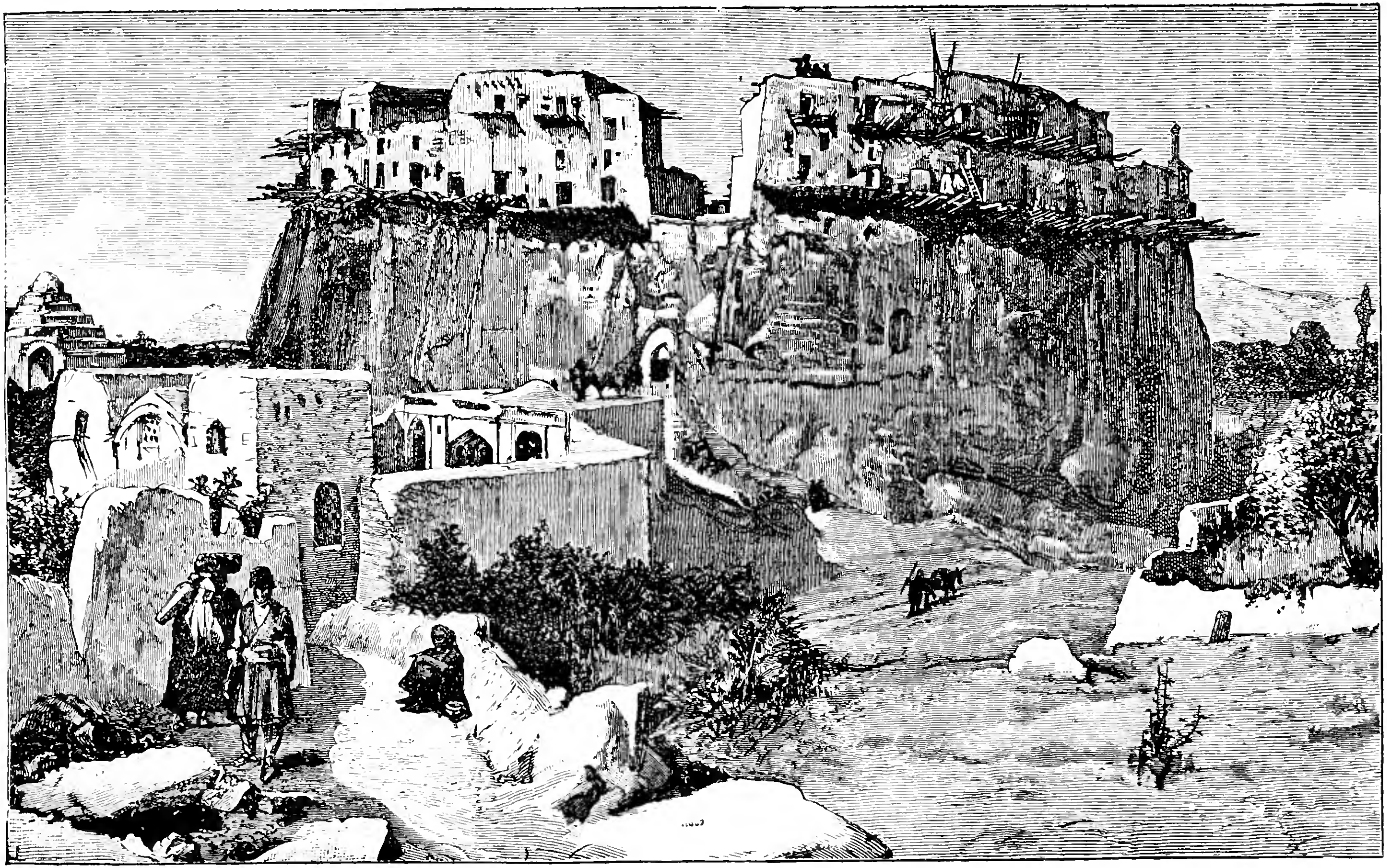

Fig. 6.—Lasgird.

in Devonshire, where they are known as a "good pair of shoes," because they protect the feet, or lower part of the wall. In the remains of the Temple of Viracocha in Peru the mud walls have a stone base eight feet in height. With these examples before us, and understanding the necessary purposes they served, we may assume that such protective substructures were generally employed wherever this particular manner of building was in use. It is highly probable that in this rude constructive detail we have the first origin of that part of the architecture in the palaces of Assyria to which the great winged bulls in the British Museum belonged. It seems now to be accepted that these palaces were constructed of crude brick, or at least this material was the principal one employed; baked or perhaps glazed brick may have been used in the exterior of the walls, but the interior was of sun-dried brick, and covered with stucco. This latter part is exactly what I saw in Persia. Along the base of these walls slabs of marble were placed, varying from three to about eight feet in height. These were generally sculptured, and the great bulls were represented on the portions of the slabs on each side of the doors. The development of this highly ornamental dado in the palace, from the base of the mud wall, is not a difficult problem to solve. The foundations I saw in the villages were formed of stones, half-bricks, or rubbish of any kind. In the better class of houses a more regular construction would be followed; and in palaces the covering of this with marble is what might be expected. I accompanied a visit of ceremony to the palace of one of the Shah's sons in Tehran, and I noticed that, in the room where we were received, slabs of alabaster, about three feet in height, went all round the base of the walls. These alabaster slabs in Persia are the counterpart of the marbles in the palaces of Assyria. In both cases they served the same purpose—they protected the lower part of the walls.

It was a source of some surprise to me to find that the Persian villages were, as a rule, exactly similar to those I had seen in the Khyber Pass and other parts of Afghanistan. They are square, formed with four high crenelated walls, and a round tower at each corner. The gateway is in the center of one of the walls, and the mud houses are huddled together inside, one might say, "anyhow." Larger villages may have six or eight towers; small towns or large ones have more wall and a larger number of towers. One of the first things that drew my attention to mud as a building material in Persia was, when in passing a small town one morning on the march, I saw some men either building or repairing the walls and towers of the place. It then struck me that these defensive walls were, with only some trifling details of difference, almost identical with the walls we are so familiar with on the Assyrian sculptures. There is the same repetition of crenelated wall and tower, and constructed of the same material. I said to myself, "These men, in the pres-

FIG. 7.—STONE DOOR, LASGIRD.

ent day, are building an old Assyrian wall of fortification." Such defenses must have begun at a very early date in Mesopotamia, long before the sculptures were produced from which we know what they were in appearance, and their construction has never ceased from that to our own time. This presents a very striking illustration of the continuity of type.

About one hundred miles east of Tehran, there is a curious village called Lasgird * (Fig. 6). It is supposed to be very old, and its circular plan is said to have been first drawn on the ground by Las, the son of Noah. The statement has already been made that the villages in Persia are square; such is the rule, and it will explain so far how a round one in their midst appears as something strange and remarkable. This great circular wall is so massive that the houses of the people are constructed on the top of it, and form in a rather irregular manner two stories. There are rude balconies, or I ought to say narrow ledges, on the outside which form communications. These are made of untrimmed branches of trees interlaced with twigs, on which mud is laid, but without a protective railing of any kind. The interior space formed by the circular wall is filled with store-rooms and places where the cattle can be safely housed in case of an attack from the Turkomans. The only entrance into this strange structure is by a small opening about four feet by three, which can be closed by a stone door turning on pivots. The smallness of this doorway was intended to prevent raiding enemies from entering during the chances of a rush, for it would be necessary to keep it open to the last moment to admit those of the villagers who were running home for protection.

I have dealt with this building material in the past; regarding its future I can say but little. In England here it was largely in use, so was wood, and that which is well expressed by the words "wattle and dab," which might be described as a combination of wood and mud. All these, as our material conditions have improved, have been slowly supplanted by the burned brick or stone. "Cob" is still in use, to a limited extent only, in north Devon. It may be assumed that it is not suited for our damp climate. In dry climates, such as Persia and Egypt, it is likely to continue, for the simple reasons that it is a cheap material, and that a comfortable dwelling can be made from it.†

I might mention a country like California as one where this material might be valuable. California has a dry climate. When I was in San Francisco, in 1873, that town was almost

* *Gird* in this word is said to have the same signification as "girdle" in English—which may be rendered as "circle."

† The author might have dwelt, to a greater extent than he has done, on the mud buildings of North America, which are abundantly exemplified in the *adobe* structures of Mexico, California, and New Mexico. As it is, he only refers to them incidentally. The log-cabins of our early settlers were of a mixed construction, in which the "dabbing" of mud played nearly as important a part as the framing of logs.—Ed.

wholly constructed of wood. Stone was feared, owing to the chances of earthquakes. While there, I visited the church of St. Francis, built of *adobes* a century before, and it had stood firm and secure all that time. It occurs to me—but I have no right to speak as an expert—that a house built of thick mud walls and wooden joists and rafters would be tolerably safe during an earthquake, unless it was a very severe shock; such a house would also be safer than a wooden one from fire, which has always been a great danger in San Francisco.

LANGUAGE AND BRAIN DISEASE.

By HOWELL T. PERSHING, M. Sc., M. D.

NOTWITHSTANDING the great number of persons engaged in learning and teaching languages, there is no general agreement as to what is the best method that can be employed. Indeed, there seems to be no belief that there can be one method which is best for both modern and ancient languages, for the pupil who must learn to converse and for him who wishes only to read. Nevertheless, there are well-ascertained facts concerning the brain, which point unmistakably to one method as the best. Hence, I have ventured to believe that all engaged in linguistic work would find it interesting and profitable to consider these facts, which, though far outside the linguist's usual field, are capable of throwing a strong light upon his work.

All the motions and sensations of the various parts of the body are represented on the surface of the brain as on a map. Thus, there is a separate brain area necessary for sight, another for hearing, another for the motions of the fingers, and so on. Each of these areas is called a center. Four of these are especially concerned in the use of language, and may therefore be called language centers: the auditory center, by which words are heard; the motor speech center, which excites and controls the vocal organs in speaking; the visual center, by which written words are seen; and the writing center, which guides the motions of the hand in writing. These centers are capable of individual development by practice, and, in order that each one may receive its due share of cultivation, it is necessary to know its relative importance in the different ways of using language.

Disease instructs us on this point by making some interesting though ruthless experiments. Inflammation, or the growth of a tumor, or the rupture or plugging of a blood-vessel, may destroy any of these centers, involving, of course, a loss of the corresponding function. Consequently, the various defects in the use of language are the subject of a large and very important chapter in the treatises on brain disease. So far as I am aware no practical use has been made of this knowledge outside the domain of medicine. Yet it would be very strange if, from the ways in which the use of language is lost, or suffers varying degrees and kinds of impairment, we could learn nothing as to how it may best be acquired. The loss occasioned by the destruction of any language center is an indication of the defect that must result from neglecting to cultivate the same center by practice; and, as disease selects now one and now another center for attack, we

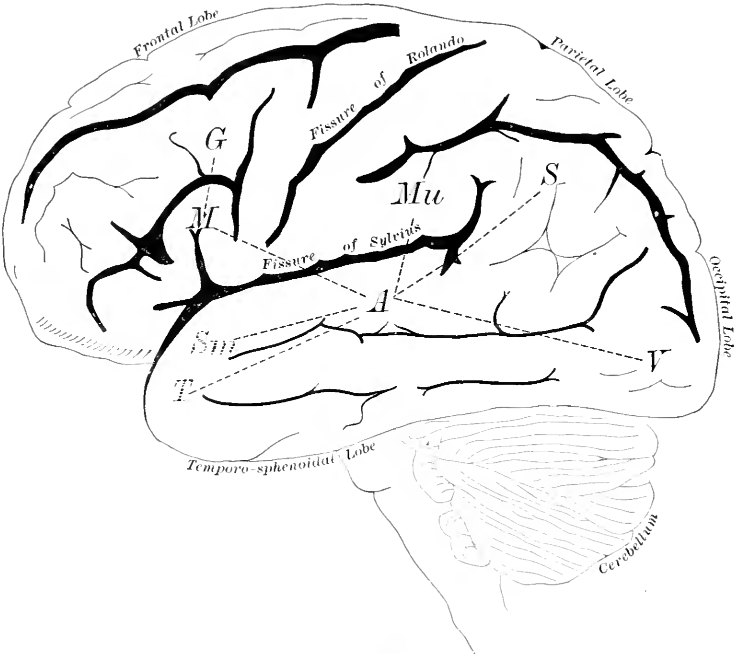

Diagram of the Left Side of the Brain. (Modified from Ecker.) A, auditory center; M, motor speech center; V, visual center; G, writing center; Sm and T, probable centers for smell and taste (dotted because on inner surface); S, provisional location of areas for perception of touch, pain, and temperature; Mu, provisional area for muscular sense.

learn the extent to which each is necessary in hearing, speaking, reading, or writing.

In the accompanying diagram of the left side of the brain, the areas marked A, M, V, and G are the four language centers. The dotted lines indicate the paths of fibers which connect them with one another and with other centers, carrying nervous impulses somewhat as a wire carries an electric current. The corresponding centers on the right side of the brain are for the most part rudimentary, and may for the present purpose be neglected.

The auditory center, A, receives the nervous impulses started by sound. When it is aroused by impulses coming from the ears, the sensation of sound occurs; but when it is aroused by nerve-currents, not from the ears, but from other parts of the brain, we have only the memory of sound. For a word to be understood, the auditory center alone is not sufficient. The sound must awaken the memories of other sensations. The word "orange," for instance, has a meaning because the auditory center, when the word is heard, arouses in the visual center the memory of the color and form of an orange; in the centers for touch, temperature, posture, and muscular sense, the memory of the sensations which occur when the fruit is grasped by the hand; in the centers for smell and taste, the memory of its peculiar odor, flavor, and tartness. These sensations are said to be associated with the sound of the word, and together with it they constitute the concept "orange." The nerve-currents passing from one center to another are called association impulses. If we have often eaten oranges, and at the same time heard the name, the auditory center whenever it perceives or remembers the sound will send vigorous impulses to the other centers, and the idea will be vivid. But if our experience of oranges has been very limited, or if the name has been rarely heard, or if instead of the correct name a merely similar sound has been heard, the association impulses will be sent slowly, feebly, and uncertainly, so that the idea will be vague. Prompt and strong associations should be cultivated as a means of securing clear and vivid ideas. The auditory center is the first language center to be developed. A child hears soon after birth, and toward the end of its first year the sounds of a few words are understood. Up to this time no words have been uttered, but the child now begins to imitate the sounds it understands and soon can use them. This requires the co-operation of the motor speech center, M, which by connecting fibers and the currents they carry combines the simpler movements of the vocal organs to form words. In the case of Gambetta, who was a loquacious politician and very successful orator, this center was excessively developed, though the brain as a whole was not remarkable. On the contrary, a study of the brain of the distinguished statistician, Bertillon, who was diffident and reticent, showed a high degree of general development, with an almost rudimentary motor speech center.

In speaking, the guidance of the *auditory* center is necessary. The sound of a word must be remembered when it is uttered. On the other hand, the effort of the motor speech center to utter a word reacts upon the memory of the sound, causing it to be more vivid. In the main the two centers work and develop together, but the auditory center is the more independent and fundamental. If a child becomes deaf, even as late as the tenth or eleventh year, it also becomes mute, unless special educational measures are employed; and in adults destruction of the auditory center interferes sadly with talking, while destruction of the motor speech center does not seem to interfere at all with the understanding of speech.

When reading is first undertaken, the auditory and motor speech centers with their association fibers are already well developed. The visual center, V, now begins to work with them. When impulses from the eyes reach this center, the sensation of sight occurs. The appearance of each letter calls up the memory of its sound through the association fibers, V A, and a number of these elementary sounds uttered in quick succession are recognized by the learner as a word. Its meaning is awakened by the auditory center, and at first it is necessary to read aloud in order to make the association impulses from this center sufficiently exact and vigorous. Later, the memories of the sound and of its utterance suffice without its actual reproduction, but in most persons these memories remain an essential part of the reading process throughout life. As this is read, the reader is doubtless conscious of the sound and of the incipient utterance of each word.

In learning to write, the motions of the hand become automatically associated with the memory of the corresponding utterance. It might be supposed that in writing the appearance of each word is recalled and copied; but this is not the case, although the visual memory may be an aid to correct spelling. Words may be written with no recollection of their appearance.

The correctness of the foregoing statements is proved by the effects of disease of the language centers, as shown by observation of speech defects during life, followed by post-mortem examination of the brain.

Destruction of the visual centers of both sides causes blindness; but when these centers themselves are unharmed, disease may be so situated as to cut off their communication with other centers. In this case the patient sees, but does not recognize what he sees, and is said to be mind-blind. If the affection is so slight that he can still recognize ordinary objects, but not written or printed words, which are more difficult, he is only word-blind. To a person afflicted with word-blindness the print of his own language is like that of a foreign one. George Eliot, with her usual sure touch in medical matters, gives an interesting illustration of this affection in the case of Tito's foster-father, Baldasarre; yet Romola was finished in 1863, when very few physicians were aware of the existence of such cases. Reading in such a case is, of course, impossible; but writing is not prevented, although the patient can not read what he has just written. Speaking and the understanding of speech are not interfered with at all.

Destruction of the motor speech center causes a much more extensive interference with the use of language. The motions of the vocal organs being no longer co-ordinated, an inarticulate jargon, or the senseless repetition of a word or phrase, is all that is left of the power to talk. The ability to write is also lost. Reading aloud is, of course, impossible; but it is also a matter of common observation in such cases that the ability to understand print is lost or greatly impaired. This proves that in most persons direct associations between visual words and ideas, if they exist at all, are too weak to be depended upon. So the understanding of spoken words is the only way of using language that is independent of the motor speech center.

But it is destruction of the auditory center that causes the most extensive loss of language. In such a case words (though they may be heard through the right side of the brain) are not understood. This failure to understand is called word-deafness. But there are other serious defects. Although the vocal apparatus is in perfect order, and there are ideas seeking expression, the words uttered are mutilated, deformed, and often totally different from the ones intended, so that intelligible speech is well-nigh impossible. This shows that in talking the most important association impulses do not go directly from the centers for ideas to the motor speech center, but to the auditory center, which, remembering the sounds, by fresh impulses arouses the motor center to utter them. Writing is still more interfered with, because it depends upon the utterance-memory, which goes astray without the sound-memory.

Does destruction of the auditory center also prevent reading? We should expect it to do so, from the way in which reading is learned, and excellent authorities say that it does. There is not enough simple and direct evidence (consisting of the inability to read during life, followed by the discovery of disease limited to the auditory center after death) to prove this, on account of the small number of available cases and the lack of attention to reading in the observation of many of them. Making allowance, however, for the difficulties in the way of gathering direct evidence on this point, the cases published support the view that in most persons the auditory center is essential to the understanding of what is read. But there is other evidence that is quite convincing. We have seen that in reading the visual center can not, as a rule, call up the ideas, else destruction of the motor speech center could not interfere with reading as it does. Nor is the motor speech center directly connected with the centers for ideas; if it were, destruction of the auditory center could not interfere with talking as it does. This leaves only the auditory center, which is abundantly capable, for the sounds of words readily awaken ideas before the other language centers begin to work and after they have been destroyed. Therefore, the auditory center must do the essential work of rousing ideas in reading. But if it does this, why is the motor center needed at all? We have seen that a beginner has to read aloud to stimulate the auditory center to do its work. In quiet reading the utterance-memory probably reacts upon the sound-memory, making it more vivid, and thus causing the auditory center to send out stronger association impulses. Possibly visual words first arouse a memory of the utterance instead of that of the sound, as I suppose. But, be this as it may, the facts clearly indicate that, in the evolution of language, the auditory center has acquired the position of a central station, through which the other language centers communicate with the centers for ideas. The sound of a word is the word itself. Printed words are only convenient symbols for recalling the sounds.

This gains in interest when considered in the light of Max Müller's views concerning the relation of language to thought. His motto is: "No reason without language; no language without reason." He contends that the scattered sense-memories can not be bound together to form a concept without a word, so words are essential to thought. He does not mean thought to include the inference that a dog makes when he sees his master start for a walk, or that which a driver makes when he sees a stone ahead of him and pulls the rein to avoid it. Undoubtedly such mental processes may go on without words. But it must be acknowledged that general or abstract thinking, such as places man so far above the lower animals, does require the use of words.

Now, what are the words that are essential to such thinking? Surely not visual words, but the words heard and uttered, as any one may know by attending for a few moments to his own thinking. And do not all the philologists tell us that the laws revealed by a study of the life and growth of language are phonetic laws?

Max Müller also alludes to the interesting distinction made by the German language in the two forms for the plural of *Wort*. *Worte* means living words actually engaged in conveying concepts from one mind to another; *Woerter* means words considered as mere objects. Visual words are only *Woerter*, dead bodies unable to support the burden of thought, mere effigies of the living sounds.

It is not meant, however, to deny the possibility of a different relation of the language centers to one another in abnormal or in exceptional individuals. Deaf-mutes may learn to read and even to speak, and doubtless to use visual words in thinking; but it is with much more than ordinary difficulty, and, in the opinion of some of their ablest teachers, the results are not so satisfactory as to warrant the abandonment of the more primitive sign-language. And it is a fact of great significance that those deaf-mutes who have once been able to hear, though the subsequent deafness was total, have a great advantage over those deaf from birth, not only in learning to read and speak, but in general mental capacity.

We are now ready to apply our facts to the practical question of how best to learn another language than our own. One method, still prevalent in schools and colleges, attempts to extract the language almost by sheer force of memory from grammar and dictionary. It has never been claimed that by this method the ability to converse could be acquired, but it has been generally assumed that by it the pupil could at least learn to read, and perhaps, if diligent, to write to advantage. Yet, even for this purpose alone, the grammatical method must be a failure in so far as it neglects to train the pupil to a quick perception and a ready utterance of the sounds of the language, for we have seen that the auditory and motor speech centers do an essential part of the work in reading and in writing. Even if direct associations from the visual center may be cultivated, as in the case of deaf-mutes, why, instead of an easy and natural method, choose an unnatural and difficult one that leads to poor results? If it should be claimed that the grammatical method, without special attention to pronunciation, does enable pupils to read, and read well, in spite of any theorizing on the subject, then it must be said without hesitation that the claim is not warranted by facts. The remarkable unanimity with which the vast majority of our college graduates neglect to read the ancient authors is a very significant thing. It seems that they are not really able to *read* the Greek and Latin writers, but only to make a translation, and that they find no sufficient reward for this slow and irksome process.

As applied to the modern languages, the grammatical method is, even at its worst, supplemented by considerable exercise in pronunciation, and the ability to read with pleasure and profit is attained in a correspondingly higher degree. Yet, in estimating this ability, there is much room for self-deception. The pupil, after memorizing inflections and rules of arrangement, begins, with the constant use of the dictionary, to read, or rather, at first, to make a translation. Persevering, he finds that he needs the dictionary less and less, and perhaps he begins to understand without the use of English equivalents. Now, let us suppose that he has reached that point where he is able to read page after page without any absolute necessity of referring to the dictionary, or even of calling up an English word. Has he, as he is apt fondly to imagine, mastered the language as far as reading it is concerned? Not at all. He has made a respectable and useful acquisition, but it is far from being perfect. Let him read a chapter of French or German, learned in this way, and then read the same amount of English—on the same subject, and, as nearly as may be, in the same style—and he will find a great difference in the time required. Let him read a plain narrative in the foreign tongue, and he will find that weariness importunes him to stop much sooner than it would if he were reading a good English translation.

Nor is this all. The meaning has been more or less misty throughout, as can readily be proved by taking the individual words out of connection and finding that many fail to call up any definite idea. And, although the ideas have appeared during the reading, they have been faint instead of vivid, because the association impulses have been sluggish and uncertain instead of prompt and true. Moreover, the subtile correspondences between sense and sound, which are allied to the unexplained power of music, together with almost all that constitutes the charm and effectiveness of style, have been lost in a struggle to get the bare meaning—no, not even the bare meaning, but a bare skeleton of the meaning. If this is a serious loss in reading plain narrative or scientific exposition, how fatal is it to the full enjoyment of poetical or rhetorical writings, where every word has been chosen with some reference to its sound! The readers of Hamerton's wise and charming essays on The Intellectual Life will remember how Tennyson's Claribel was read by a thoroughly cultivated Frenchman, who had long studied English and read abundantly of the literature, but had never become really familiar with English sounds:

"At ev ze bittle bommess
  Azvart ze zeeket lon
At none ze veeld be ommess
  Aboot ze most edston
At meedneeg ze mon commess
  An lokez doon alon
Ere songg ze lintveet svelless
Ze clirvoiced mavi dvelless
  Ze fledgling srost lispess
Ze slombroos vav ootvelless
  Ze babblang ronnel creespess
Ze ollov grot replee-ess
Vere Claribel lovlee-ess."

Ought we to be content to read the French and German or the Greek and Latin poets in any such fashion?

But even such absurdly incorrect sounds serve some purpose, for they keep the association currents in their natural course through the auditory center. They are like a debased and mutilated currency, whose low and uncertain value discourages and confuses trade, but which may, in default of anything better, still keep the stream of commodities flowing in the natural channels.

Now suppose a student, having reached the stage of progress above indicated, visits the country whose language he has been reading. What he hears at first is almost wholly unintelligible, though the same words in print would be familiar. A little later it is not uncommon to hear a sentence without comprehending it at all, when suddenly it will flash upon the mind of the hearer as though seen in print and pronounced by himself, and then it is readily understood. The same thing occurs in listening to one's native tongue when the auditory center has been slightly damaged by disease.

In these cases the damaged or unpracticed auditory center recognizes but a part of what is heard, but this is enough to suggest to the well-practiced visual center the complete memory of the visual words, which then calls up their usual, possibly incorrect, sound and utterance, with the associated meaning.

As time passes, the strange sounds, through constant repetition and efforts to imitate them, grow familiar and become strongly associated with every-day experiences, so that as soon as a word is heard the idea is vividly present in consciousness. If the student reads now, he finds his former disadvantages greatly diminished. He reads faster and with less fatigue, finding a clearness and vigor of meaning before unknown. It is not because his vocabulary is larger, but because it is more efficient. The auditory center, which formerly, through lack of practice, failed to properly perform an essential part of the work, is now, at the suggestion of the visual center, quick to recall each sound, and, re-enforced by the utterance-memory, it is quick, accurate, and vigorous in reviving each idea. The work of exchange is now done by the true coin of the realm.

The more carefully any teacher or thoughtful student will consider his own experience, the more he will be convinced of what the facts of brain disease demonstrate, that a good method of learning any language, whether the aim be to speak or only to read, must make the thorough training of the auditory and motor speech-centers a fundamental object. This training can be perfectly attained only by living where the language to be learned is spoken; but, although the difficulties at home are great, if the essential requisite is only kept in view, a great deal can be accomplished. This we owe to the clear insight and faithful work of the inventors of the natural method. Although this method is well known, it may not be amiss to give a sketch of how the best results may be obtained.

The first part of the course of instruction should be devoted exclusively to the sounds of the commonest words, their reproduction by the pupil, and the formation of strong associations between them and actual experiences.

The correct sounds must receive a degree of attention and reverence that would do credit to a music-master. Inevitable awkwardness in pronunciation should be corrected, not only by repeated efforts to imitate what is heard, but also by careful instruction as to the exact position and movements of the vocal organs in making the difficult sounds. This is of great importance, as it reacts upon the auditory memory and does much toward fixing a clear conception of the correct sound of each word. Probably very few Germans or Frenchmen have a clear conception of the sound of "*th*" in English; but had they from the first, whenever attempting this sound, been required to place the tip of the tongue between the teeth (which is never done in speaking French or German), there could be but little difficulty in pronouncing or recalling it. And in the same way a clear understanding of the fact that the French *u* and German *Umlauts* require the lips to be thrust forward and partially closed, will enable one to acquire these sounds far more readily than he otherwise could.

An *objective* expression of the meaning of words and sentences should always be sought. Things actually impressing the senses cause a more vigorous action of the brain than any recollection of them; consequently they make associations stronger and meanings more vivid. Although the exhibition of common objects and pictures, in teaching a vocabulary, may to the superficial observer seem childish and wasteful of time, it is in reality wise and economical.

The memorizing of sentences, reading aloud, listening to others read, and writing from dictation should all be employed, in addition to simple conversations between teacher and pupil, as valuable exercises. What is read at first should be carefully graded, so that the ideas may be awakened without having recourse to English, thus avoiding the habit of making a bad translation, which is often injurious to a school-boy's use of his own language.

As a pupil in the first stage of progress is pretty sure to go astray when left to himself, the work should be so arranged that all the time allotted to the language may be spent with the teacher. Tasks for outside preparation should not be assigned until the appreciation of the correct sounds is keen enough to prevent the contraction of vicious habits of pronunciation. Grammar should at first be taught only as it becomes available for immediate use; but, later in the course, it should be taught systematically, and copious outside reading should be assigned.

A student who can neither go abroad nor command the services of a good teacher is at a great disadvantage; but he may still, if he has had a fair start, do much toward the cultivation of the auditory and motor memories of the foreign words with their proper associations, and thus greatly improve his ability to read. He should attend carefully to pronunciation, and practice reading aloud. When a new word occurs, the first thing is to get its correct sound, and the next to associate it with some actual experience, if possible; if not, then with as vivid an idea as can be recalled. The English equivalent must be dropped from consciousness as soon as the idea is present, so that the association may be a direct one. It is an advantage to use a dictionary with words and definitions in the same language. Reading on subjects in which one is specially interested is much better than general reading. The memorizing and frequent repetition of interesting passages will pay abundantly for the time and trouble.

The great difficulty in working alone is to hear enough of the language to keep the auditory center familiar with its correct sounds. To this end, every opportunity should be taken to converse, or to hear a sermon or a play, in the foreign tongue. In many American cities such opportunities are not rare, especially as to German.

For this purpose the phonograph will no doubt be made of great service. With its aid choice passages in literature or scientific exposition, as rendered by a good reader, can be repeatedly heard and pronunciation and accent imitated at the pupil's convenience. I have no doubt that some process of cheaply multiplying the phonographic cylinders or ribbons will, before very long, enable us to enjoy whole books in this way, thus saving our weary eyes and economizing the energy of the brain, while giving a greater pleasure.

I see no reason why Latin and Greek may not be taught to advantage by some such method as the one that has been outlined. The uncertainty as to what the original sounds were, though embarrassing, is not nearly so great as one would naturally suppose. Philological science has reached such perfection that at least a close approximation to the correct sounds could be agreed upon and registered by the phonograph.

As Hamerton suggests, a phrase-book could doubtless be made for teaching each language by the natural method. A student once fairly started in this way could not fail to make greater progress in grammatical and philological knowledge, as well as to find the classical authors more interesting.

In conclusion, it may safely be said that the reader who has given his assent to the deductions here made from the facts of disease will not hesitate to go further and concur in the opinion that pedagogy will in the future find a scientific basis in a knowledge of the functions of the brain. Its career must somewhat resemble that of the art of medicine. There were great physicians before Harvey found a starting-point for scientific physiology; yet the debt of practical medicine to physiology is now well-nigh incalculable. So it will be with the art of teaching: noble work has been done for its advancement in entire ignorance of the organ whose best development it seeks; but now, since there is already a large and constantly increasing fund of knowledge concerning the working of the brain, teachers who are not bound to the traditions of the past, but are looking eagerly for every means of improving their art, will assuredly not fail to take advantage of the new knowledge.

The result must be an enormous gain for the children of the future.*

An influence of a total solar eclipse on air pressure has been deduced by Herr Steen from the comparison of the records of fourteen Norwegian ships between Panama and Madagascar, during the eclipse of August 29, 1885, four of the ships having been within the zone of totality and four others very near it. Two maxima of pressure, separated by a minimum, were revealed. The double wave is explained by Herr Steen by assuming that during a solar eclipse day is changed to night for a short time, and the transition is much like the ordinary change from day to night in the tropics, where the twilight is short. There the curve of air pressure has regularly a maximum about 10 P. M., some time after sunset, and a minimum about 4 A. M., shortly before sunrise; while a second maximum appears about 4 A. M. A total solar eclipse would naturally act in a similar way.

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* References.—Any reader interested in the foregoing argument would do well to verify the statements of fact on which it is based by reference to some of the following well-known authorities:

For a very clear, popular account of the functions of the brain, see Prof. M. A. Starr's article, The Old and the New Phrenology, Popular Science Monthly, October, 1889.

For a more complete account, consult the same author's Familiar Forms of Nervous Disease; Gowers's Diseases of the Nervous System, pp. 454–465, American edition; and the text-books of physiology by Michael Foster and by Landois and Stirling.

For defects in the use of language, besides the above, see Th. Ribot, Diseases of Memory, chap. iii; Moebius, Allgemeine Diagnostik der Nervenkrankheiten; Ross, Diseases of the Nervous System, chap. xviii; H. C. Wood, Nervous Diseases and their Diagnosis, chap. ix; Gowers, *loc. cit.*, pp. 540–555; also Starr, The Pathology of Sensory Aphasia, Brain, July, 1889, and Apraxia and Aphasia, Medical Record, October 27, 1888.

For a discussion of word-blindness and mind-blindness, illustrated by cases of great interest, see Charcot, Leçons sur les Maladies du Système Nerveux, tome iii, pp. 154–189.

For a discussion of the working of the brain in reading, with references to previous researches, see Ein Beitrag zur Lehre von den Lesestoerungen, Weissenberg, Archiv f. Psychiatrie, xxii, 2.

The most philosophical and elaborate work on the disturbances of speech is that contributed by Kussmaul to Ziemmsen's Cyclopædia, vol. xiv.

In consulting any author on this subject the date of writing must, of course, be considered, as every year adds materially to the common store of available facts.

A CHAPTER IN METEOROLOGICAL DISCOVERY.

By JOHN COLEMAN ADAMS.

ONE of the most interesting phases in the history of scientific research is what may be called the co-operative feature. No great machine is the invention of one mind. Few great discoveries have been made in complete accuracy by any one man. A locomotive is a mosaic of inventions, discoveries, and improvements. It would be impossible to estimate the number of minds which have contributed to the mighty structure, and have slowly built up its complex perfections. The names of Stephenson, Jervis, Winans, and Allen, in their successive contributions to the devices by which the locomotive has increased its capacities, but faintly hint the immense number who have given some detail, some great or small modification and improvement by which the vast and impressive result has been built up. In the same way, every science grows to its completeness by the accumulating discoveries of individuals, added from year to year and century to century. Astronomy has gathered its harvest of results by the hands of hundreds of patient toilers. Copernicus established the true center of the solar system; Kepler added the three great laws which bear his name, relating to the orbits and the periods of the planets; Newton contributed the law of gravitation. The science has been a growth, fed by the thoughts and the painstaking labors of many minds. And while each of these great men has furnished a distinct and complete contribution to the total knowledge in the science, each has also depended upon his predecessors for co-operation and the data which made his own task possible of accomplishment.

Just such a process as this has been going on in the young and growing science of meteorology. It may be doubted if any other branch of science in our century furnishes a more curious and valuable illustration of the progress of discovery in a given field, the corrections applied by later discoverers to the work of their predecessors, the accumulation of facts and data till they are sufficient for the formation of a working hypothesis, the modifications of the hypothesis in the light of new data, the application of the theory to practical affairs, and the unification of the set of phenomena thus investigated with other and all facts in the same branch of science. The history of the investigations which created our great system of observation and record, and made it possible for a whole people to get daily bulletins of the morrow's probable weather, is one of the most striking in the whole history of science. Let us sketch it as it lies in the annals of the learned societies of America, as yet both uncollected and unconnected.

It will be seen how discovery started from a casual hint based on the observations of a keen and well-trained mind; how it was stimulated in a later observer, who bent himself to the painstaking collation of facts bearing on one special set of phenomena; how these facts finally warranted him in advancing a hypothesis; how this hypothesis was opposed and criticised; how it maintained itself in the face of increasing light; how more extended observations confirmed it and enlarged its application; how it became the basis of all subsequent investigation; how it was sustained by the testimony of other observers working along similar lines; and how to-day it is at the very corner-stone of the meteorological science in America. To this narrative let us turn.

It may be fairly presumed that the well-known suggestions of Benjamin Franklin, based on the occurrence of a northeasterly storm in Boston shortly after one was noted in Philadelphia, was the first definite contribution to the scientific knowledge of North American storms and their movements of transition. Though that contribution was little more than a speculation, it was nevertheless one of those sagacious anticipations of results which marks the true scientific genius. In a letter to Jared Eliot, dated at Philadelphia, July 16, 1747, Franklin says: "We have frequently along this North American coast storms from the northeast which blow violently, sometimes for three or four days. Of these I have had a very singular opinion for some years—i. e., that though the course of the *wind* is from northeast to southwest, yet the course of the *storm* is from southwest to northeast; that is, the air is in violent commotion in Virginia before it moves in Connecticut, and in Connecticut before it moves at Cape Sable." In another letter to Eliot, dated at Philadelphia some two years later (February 13, 1749–'50), Franklin says: "You desire to know my thought about northeast storms beginning to leeward. Some years ago there was an eclipse of the moon at nine in the evening which I intended to observe, but before night a storm blew up at northeast and continued violent all night and next day; the sky was thick clouded, dark, and rainy, so that neither moon nor stars could be seen. The storm did a great deal of damage all along shore, for we had accounts of it in all the newspapers, from Boston, Newport, New York, Maryland, and Virginia. But what surprised me was to find in the Boston newspapers an account of an observation of the eclipse made there, for I thought as the storm came on from the northeast it must have begun sooner in Boston than with us, and consequently prevented such observation. I wrote to my brother about it, and he informed me that the eclipse was over there one hour before the storm began. Since which I have made inquiries, from time to time, of travelers and of my correspondents to northeast and southwest, and observed the accounts of newspapers from New England, New York, Maryland, Virginia, and South Carolina, and I find it to be a constant fact that the northeast storms begin to leeward, and are often more violent there than to windward."

Those letters are probably the earliest literature on the subject of North American storms, the first documents of scientific value in the long series of observations and of studies which have brought us to our present valuable knowledge. Undoubtedly, this fact, which had suggested itself to Franklin, had been observed before by fishermen, by mariners, and others, accustomed to the practical observation of the weather. But this is the initial point of its treatment as a scientific phenomenon. Between the two kinds of observation there is a world-wide difference. The observer is not always nor often the seer. There are a hundred thousand who can note a fact for one who can draw an inference from it. A good many myriads of generations had noted the ebb and flow of the tides before anybody noted a connection between these facts and the daily passage of the moon across the meridian. It is likely that a good many fishermen and sailors and captains had talked over the curious fact that the first signs of the coming northeaster seemed to be from the leeward of its characteristic wind. Perhaps some of these unscientific folk had propounded their crude theories about the motions of storms to the little knots of comrades about the cabin fire or under the forecastle's dim lantern. But, being unscientific people, they did not know how to gather and marshal their facts, draw their inferences, and declare their hypotheses. And so Dr. Franklin must have the credit of first propounding this doctrine about American storms. Many years elapsed before his became the accepted view, and people understood that the easterly storms of New England, and indeed of the whole country, were travelers from west to east, and not visitants from the sea, drifting up the coasts and inland. The lack of facilities for observation, the dearth of data, the infrequency of communication, the almost utter neglect of the phenomena whose study in recent years has founded the science of meteorology, were all conditions which greatly retarded the knowledge of meteorology in our own country, and made it impossible to trace the connection of weather in one region with that in others.

William C. Redfield.—The serious and consecutive study of the motions of North American storms may be said to have begun with the investigations of William C. Redfield, one of the most painstaking, broad-minded, and sagacious of American scientists. So competent an authority as Commodore Maury has called him "the Kepler of storm physics." Prof. Denison Olmstead, of Yale College, in a brief memoir published in the American Journal of Science (vol. lxxiv), says: "The honor of having established on satisfactory evidence the rotary and progressive character of ocean storms, and determining their modes of action and laws, it is due alike to the memory of the departed and the credit of our country to claim for William C. Redfield."

Redfield was a Connecticut man, born at Middletown in 1789. He was a naval engineer, and, besides his valuable contributions to this science, he was much interested in various other branches, and especially in the problem of increasing the speed of steamboats. Olmstead declares him to have been the first man to suggest a great railway system between the Hudson and the Mississippi.

It was in the year 1821 that Redfield began the study of what he called "Atlantic storms." He was led to it by a casual circumstance, like that which called out Franklin's hint as to the direction of the movement of these storms. And let it especially be noted, as the story of his investigation is told, how clearly that story teaches the value of close and patient study along some single line of facts, until their relations are laid bare and their meaning uncovered. Redfield is an illustration of the value to the world of men who know, not a great many things a little, but a few things a great deal.

In the year 1821 a severe storm prevailed along the Eastern coast, which for many years was known as the "great September gale." It held that title until September, 1869, when another and more remarkable one occurred, which rather disturbed its claim to the honor. It was a little time after this first storm that Redfield, while making a journey in Massachusetts, was struck by a somewhat curious fact. He noticed that in Massachusetts the trees prostrated by the wind, all lay with their heads to the southeast, showing that the gale there was from the northwest; but in Connecticut the trees blown down in the same storm lay head to the northwest, showing that the gale had been a southeast one. He ascertained, moreover, that when the wind was blowing southeast in Middletown, his home, it was northwest at a place not seventy miles from there. It was then that the idea flashed across his mind that the gale was a progressive whirlwind. That was a great thought. It was such a flash of perception as came to Newton when he connected the falling apple with the planets in space. It was such an insight into the meaning of a fact as James Watt had when he saw the possibilities of the force that was rattling the lid of the kettle on his mother's fire. The development of that idea was destined one day to put Redfield in the ranks of the great scientific thinkers of his day. He made this storm the basis of his investigations, following his researches into its movements by a careful collection of facts in relation to others like it. For ten years he studied, and examined and compared his facts, before he published his theory of storms. He noted the occurrence of several great gales, and set about collecting all the facts possible in reference to them, carrying on a wide correspondence, and examining a multitude of witnesses. He sought out the marine reports as to all vessels coming into port soon after the storm, examined their log-books and talked with their captains. In the case of the great Cuban hurricane of 1844, he collated one hundred and sixty-four different accounts. He noted the latitude and longitude of the vessels at sea, or the observers on the coast, when they took the gale, the direction and force of the wind as they experienced it, the direction in which it veered, the states of the barometer, and all cognate facts. Then he charted the whole and studied its meaning.

It was in 1831, ten years from the time in which he first observed the effects of the September gale and drew his inferences from them, that he published an article, "On the Prevailing Storms of the Atlantic Coast." In it he gave an account of the gale of 1821, which he describes as "exhibited in the form of a great whirlwind." He had now made several important conclusions in reference to this class of storms: 1. He held that they often originate in the tropical latitudes, frequently to the north and east of the West India Islands. 2. That they often cover at the same moment of time an area of from one hundred to five hundred miles in diameter, and that they are most violent nearest the center of this area, and least energetic about the exterior lines. 3. That while in the tropics these storms move from east to west till they reach the parallel of 30° north, when they suddenly recurve to the north and east, and move rapidly along lines generally parallel with the Atlantic coast of the United States. 4. That the direction of the winds along the greater portion of its storm-tracks *is not the same as the direction of the storm itself.* 5. That when in these northerly latitudes these storms, while moving in a northeast course, begin with a wind from east to south, and terminate with a wind from west to north. 6. That on the outer portion of the track, north of the parallel of 30° or within that portion lying farthest from the American coast, these storms exhibit at the commencement a southerly wind which, as the storm comes over, veers gradually to the westward, a quarter where it is found to terminate. 7. In the same latitudes, but along the central portion of the track, the first force of the wind is from the southeast, but after blowing for a certain period it changes suddenly to a point nearly or directly opposite. 8. On that portion of the track nearest the American coast or farthest inland, if the storm reaches the continent, the wind commences from an east or northeast point and veers more or less gradually by north to northwest.

This was certainly a very important series of conclusions, and it establishes certain principles or laws in regard to a certain class of North American storms beyond cavil. Redfield had thus shown that many at least of the great storms which traverse the Atlantic coast come from the tropics east of the West Indies and describe a great parabola in their course; that the direction of the wind in these storms was entirely a distinct matter from the direction in which the storm is moving; and that this storm is a system of winds, blowing whirlwind-fashion about a central point, in a direction contrary to that of the hands of a watch. That is the substance of Redfield's discovery; and it is one of the most important contributions ever made to the science of storms, not alone in its purely scientific relations, but also, as we shall see, in a most practical way in the service of mariners.

Just here we touch an interesting episode of Redfield's career, in his connection with Sir William Reid, an English engineer-colonel at Barbadoes, himself deeply interested in this subject, and an investigator of the law of storms in general. Redfield and Reid entered into a correspondence upon the subject which lasted for twenty years, and which Redfield declares was most serviceable to him. But, as Colonel Reid's earliest inquiries were based on a storm of 1831, ten years later than the one which gave Redfield his first hint of a theory, it may still be maintained that Redfield was the first to grasp the new facts in all their meaning. He acknowledges an indebtedness to Colonel Reid as well as to Piddington, in his essay on "Asiatic Storms." But their work could have done little more for him than to confirm his own thought and guide his investigations. It remained for this early student of these phenomena to follow the great storms of the Atlantic from their breeding-place near the "doldrums," in their curving path through the Gulf of Mexico and along the United States coast, proving that these vast hurricanes of the West Indies are progressive storms, moving westward till central in the Gulf and then recurving toward the northeast, retaining their essential characteristics, though somewhat less violent than in their beginnings. This was the scope of Redfield's investigations. He indicated the track of one entire class of American storms, and showed them to be great circular movements of the air, like immense whirlwinds or cyclones, traveling bodily over wide areas.

A word more ought to be said before we pass from the work of Redfield, as to his theory of the direction of the winds about the center of a cyclone, a point much debated since his day, and in which he was singularly correct in his judgment. At the time he made his investigations, everybody supposed that these great storms were disturbances in which the winds blew straight away from one point of the compass; and one of the theories advanced in opposition to this, held that the winds in these systems blew radially in to a common center. Redfield, however, maintained that they blew neither radially toward the center, nor yet in circles around it, but as water or smoke in a vortex, with a constant inclination to the center. Here, too, he came very close to the most commonly received doctrine of this present time; and it proved in entire harmony with the law propounded by Ballot—a law which may be thus expressed: "The wind which blows around an area of low barometer, blows neither in circles returning on themselves, nor directly toward that point; but it takes a direction intermediate, approaching, however, more nearly the direction of circular curves than of radii to a center." Redfield's researches also showed that the winds about a low-pressure space blow in a direction contrary to that of the hands of a watch.

One fact more should be stated in reference to the nature of Redfield's work and its practical value. Few discoveries in science have ever been turned more quickly to the benefit of mankind; for one of Redfield's first undertakings, after establishing these laws of the great Atlantic storms, was to formulate certain rules for the management of vessels during these gales, by which the heaviest force of the storm may be avoided. One of the completest answers to the skeptical queries of matter-of-fact people as to the utility of purely scientific studies, is found in the fact that the outcome of Redfield's studies as attested by United States naval officers like Commodore Rodgers and Lieutenant Maury, was an immediate service to ship-masters in showing them how to avoid the heaviest parts of a cyclone, and save their vessels the risk and the wear and tear of an encounter with the violent winds of the storm-center.

JAMES P. ESPY.—But we must leave the work of Redfield, important though it was, and move on, in fulfillment of our purpose, to note the contributions of those other men who helped to complete our knowledge of great American storms.

In the year 1850, Prof. James P. Espy, one of the most original and talented of American meteorologists, published his conclusions in regard to the character of American storms, which must be regarded as the next step in the enlargement of our knowledge on the subject. His views were presented in a work entitled The Philosophy of Storms, the fruit of earnest and painstaking studies. The great feature of this work was its presentation of a new class of storms. Espy directed attention to those great atmospheric disturbances which no one hitherto had dealt with, which move across the continent from west to east and which do not originate in the West Indies. Redfield's attention, was confined to his favorite West Indian storms, which travel *via* the Gulf of Mexico. Espy reminded the public that these were not the only great storms which visit the United States. "There are rain and snow storms," said Espy, "which from November to March, at least, travel from west to east. These storms are first heard of west of the Mississippi and sometimes as far north as Iowa; and they often travel from the Mississippi to the Connecticut in twenty-four hours." He concluded that these storms must originate in the far West, at that time only a wilderness, and so beyond the outposts of observation. Espy did not assert that these storms differed in character from the ones with which Redfield had dealt. He only reminded the world that the West Indies were not the only place where storms were generated. In so doing, he accurately pointed out the origin of a large proportion of American storms. The storms which Redfield studied were really the least, in point of numbers, among the storms which visit the continent. But Redfield's observations were confined to the seaboard, so that he necessarily did not have his attention drawn to this second class of great storms. Like many later Eastern men, he did not realize what a prominent part the West plays in the economy of the country.

In two respects Prof. Espy became the critic of William C. Redfield. He held that the winds related to great storms blow radially to a center, either obliquely or directly. He also believed that the depression of the storm-center was caused, not by the centrifugal force generated by the motion of the winds, as Redfield was inclined to maintain, but was on account of the rarefaction of the air through the heat developed by the condensation of vapor in the form of rain or cloud. The latter theory proved of more value than the former, and will stand as one of Prof. Espy's additions to the meteorology of North America. The Western origin of many storms and the function of heat in the development of cyclones—these are the two contributions of Espy to the science of American storms.

Prof. Hare.—But Espy's eyes were not sharp enough to see all the facts about the origin and movement of our great disturbances; and so, as he made certain suggestions which added to the value of Redfield's discoveries, his own in turn received amendment. The chief of Espy's critics was that eminent American scientist, Dr. Hare, whose queries in regard to Espy's conclusions were pertinent and searching. He asked, among other things, "whether agreeably to the observations of Franklin and general experience confirming them, our storms producing northeasterly winds do not travel from southwest to northeast; whether their traveling thus does not warrant the opinion that they originate in the Gulf of Mexico; whether the observations of Redfield do not establish the fact that certain storms travel from the Gulf along the coast; how the observations of Franklin, confirmed by the general impression that they were sagacious, can be reconciled with those made by Loomis (locating the place of origin of some storms in the Northwest of the United States), unless there be two kinds of storms, one of which travels from southwest to northeast and the other from northwest to southeast; and whether it can be correct to confound these two kinds of storms under one generalization—i. e., storms moving from east to west." Of course, these slight strictures did not seriously affect the validity of Espy's conclusions, any more than they added materially to the sum of Redfield's. They simply helped to bring all the facts now discovered into relation, and take the emphasis off any especial class, the peculiar study of individuals. They show how valuable are all individual contributions to the growth of a science, and how, when there is a number of observers in any one field, each may be a check upon the others and supplement their defective data or inferences. Redfield discovered the origin of one class of storms, and laid down the laws of their movement and internal motions. Espy pointed out a new point of origin of storms, and threw some new light on their internal winds. Hare pointed to still another quarter whence these great whirlwinds arise, and directed attention to the various tracks which they pursue; and the investigations which led to these results extend over a term of perhaps thirty years, from the year 1821 to 1851.

Elias Loomis.—It was about this period that Prof. Loomis, of Yale College, was prosecuting his studies in meteorology, and especially in regard to storm-motions, which have since become a valuable part of our knowledge. He was a later worker in this field, and his labors were made the more valuable from the fact that the country had been growing rapidly, especially toward the Northwest, and he was thus enabled to command much new material in the way of observations from this quarter of the country, which had not been available for the others. Loomis found that great storms, of like character to those reported from the southwest and the Atlantic coast, also swept the northern parts of the country, with identical details, in respect to winds and motions. These were included in his studies, and thus the generalizations in respect to our storms were greatly enlarged. Perhaps the gist of Loomis's conclusions in this matter is condensed into this paragraph from his Meteorology, which, by the way, was the first treatise of any pretensions upon this subject published in this country. He says: "The average direction of storm-paths across the United States is toward a point nine degrees north of east, but it varies somewhat with the season of the year, being almost exactly east in summer and inclining more to the north in the winter. Occasionally storms depart very much from the average track, their course being sometimes directed toward the southeast and sometimes toward the northeast, and occasionally their course for a day or so has been almost exactly north. Their average velocity of progress is twenty-six miles per hour, being twenty-one miles in summer and thirty miles in winter; but sometimes they attain a velocity of fifty miles in an hour, and sometimes they remain for a day or two sensibly stationary."

Blodgett, Mitchell, Coffin.—Several other names deserve mention, as belonging to earnest investigators and theorists in the early fields of American meteorology. Loren Blodgett, M. N. I., published in 1857 a work on the climate of the United States, far superior to anything previously sent out. About the time of Redfield's earlier work, Prof. Mitchell, of the University of North Carolina, propounded a theory which seems to have attracted but little attention—as indeed it deserves but little—maintaining that certain storms, especially those of the Atlantic coast, are the result of a gyratory motion about an axis parallel to the plane of the horizon. This proposition he held in opposition to Redfield, whom he mentions as contending for the revolution of the wind about an axis perpendicular to the plane of the horizon. This speculation of Prof. Mitchell was of less value to science than his suggestion of the plan of daily maps, showing the aspects of the sky, that cloud boundaries might be traced, and thus their extent and movements discovered—an idea which is incorporated into the every-day work of the Signal Service at Washington. Still another of the meteorologists of service in the line of investigation we are describing was Coffin, the author of Studies in the Winds of the Northern Hemisphere.

Dr. Joseph Henry.—When the study of the laws of storms and their movements in America had gone as far as this, it had reached a point beyond which it could not proceed without a more abundant material in the way of observations and statistics. More data were required, if larger demonstrations were to be made. The time had come when no great advance in the knowledge of storms could be had, unless they were carefully studied over large areas, their actions noted at a great number of points at once, and the information thus gained reduced to order. Of no other science is this so true as of meteorology; of no branch of meteorology is it so true as the observation of storms. Eternal vigilance is the price of all knowledge in this great field. And we are now at a point in the progress of the study of American storms when a great advance was made. Prof. Joseph Henry, the Director and Secretary of the Smithsonian Institution, and one of the very foremost of American physicists, put into execution a plan long conceived and long agitated, securing a system of daily observations throughout the United States and Canada. He first arranged for daily reports by telegraph, and was the first to have the atmospheric conditions over a large territory indicated on a map. He paved the way for the systematic researches of that department of the public service which has since been organized as the Weather Bureau, established in 1870, the most important work in the interests of this science which has ever been undertaken. For it is now possible to put in the hands of a few trained minds at Washington, three times in every day, an amount of data many times more than all that Redfield or Espy or Hare collected in years of study. It is to the efforts of Dr. Henry, following upon the patient research of the men whose work we have thus slightly traced, that we owe the rise and growth of the science as it stands to-day. An army of observers, drilled to the greatest precision of scrutiny, on land and on sea, on hill-tops and in the valleys, in every latitude from the equator to the polar circle, scans the heavens and watches the earth for every meteorological change. The charting of great storms, the making of forecasts, the posting of storm-warnings, all indicate the condition which this science has slowly attained, through the combined and cumulative labors of so many patient observers. From the conjecture of Benjamin Franklin, about the northeast storms beginning to leeward, to the splendid system by which the movements of a great storm are announced and described almost as regularly and clearly as the movements of trains on a railway system is a long advance. It is an advance which shows how much we have to be proud of in this great national work, as it has grown and developed at the hands of our own countrymen. It illustrates, moreover, the fact that in the researches of science, as in all the labors of humanity, every man's work tells, and enters into the great result. Patient toil concentrated upon chosen subjects never fails to yield its due results, valuable for all men. Even the most abstruse scientific research may have, nay, will surely have, its issue in practical good to men; and the most retiring and isolated student in his solitary studies is as true a servant of his kind as he who sows and reaps acres of wheat, or weaves the cloth that clothes men's bodies. When William C. Redfield was gathering the facts about his Three Great Atlantic Storms, he was doing as direct a service to the future shippers and navigators of the Atlantic coast, and the cotton-growers of Georgia and Alabama, as if he had furnished cargoes for their ships or markets for their cargoes.

A COMPARATIVE STUDY OF SOME INDIAN HOMES.

By R. W. SHUFELDT, M. D.

WHILE attached to a military expedition against the Sioux in Wyoming in 1877, I saw those Indians construct at the various camps we made what I take to be the most primitive form of house built by human hands. It was simply a shelter, or *tepee* as they called it, made with the green boughs cut from the cottonwood trees. Without any especial preparation of the ground, they implanted the cut ends of the limbs in two parallel rows about eight feet long and five feet apart. The tops were adroitly bent over the inclosed space and fastened together along the middle line, thus creating a semi-cylindrical shelter open at both ends. These *tepees* were merely intended for two or three men to sleep in, all the cooking and other arrangements being performed outside.

In permanent summer camps these *tepees* are built in a subhemispherical shape, the ground upon which they are erected being previously cleaned off, moderately scooped out, and the earth thus obtained banked around the in-stuck ends of the boughs on the inside of the structure. They are then trimmed up and properly covered outside with long prairie grass, so placed as to shed the rain. Often, too, they threw an old buffalo-hide over the top as an additional protection.

In 1886 I observed the Navajos in northwestern New Mexico building similar houses to the ones I have just described; but those Indians also build a more durable structure in their *hogan* —a conical house of logs plastered with mud, and with a door at the side. Navajos, too, are improving in their home-building, more especially where they have taken up their abode in the neighborhood of frontier military garrisons. All this I have explained in a paper read before the Anthropological Society of Washington (March 17, 1891), and which appeared in the Proceedings of the United States National Museum.*

Many other Indians build these temporary shelter-houses, and among them the Apaches of Arizona. In Fig. 1 of the present paper they are well shown as they are constructed by those Indians in a summer camp. Here they have protected the top by large pieces of old canvas, thus making one of them quite waterproof. Corbusier, in the September number of the American Antiquarian for 1886, well describes one of these shelters as erected by the Apache-Mojaves. He says: "They live in circular brush huts (*u-wah'*) about five feet high, and from six to eight

* Shufeldt, R. W. The Evolution of House-building among the Navajo Indians. Vol. xv, pp. 279–282, Plates XLI–XLIII. Washington, 1892.

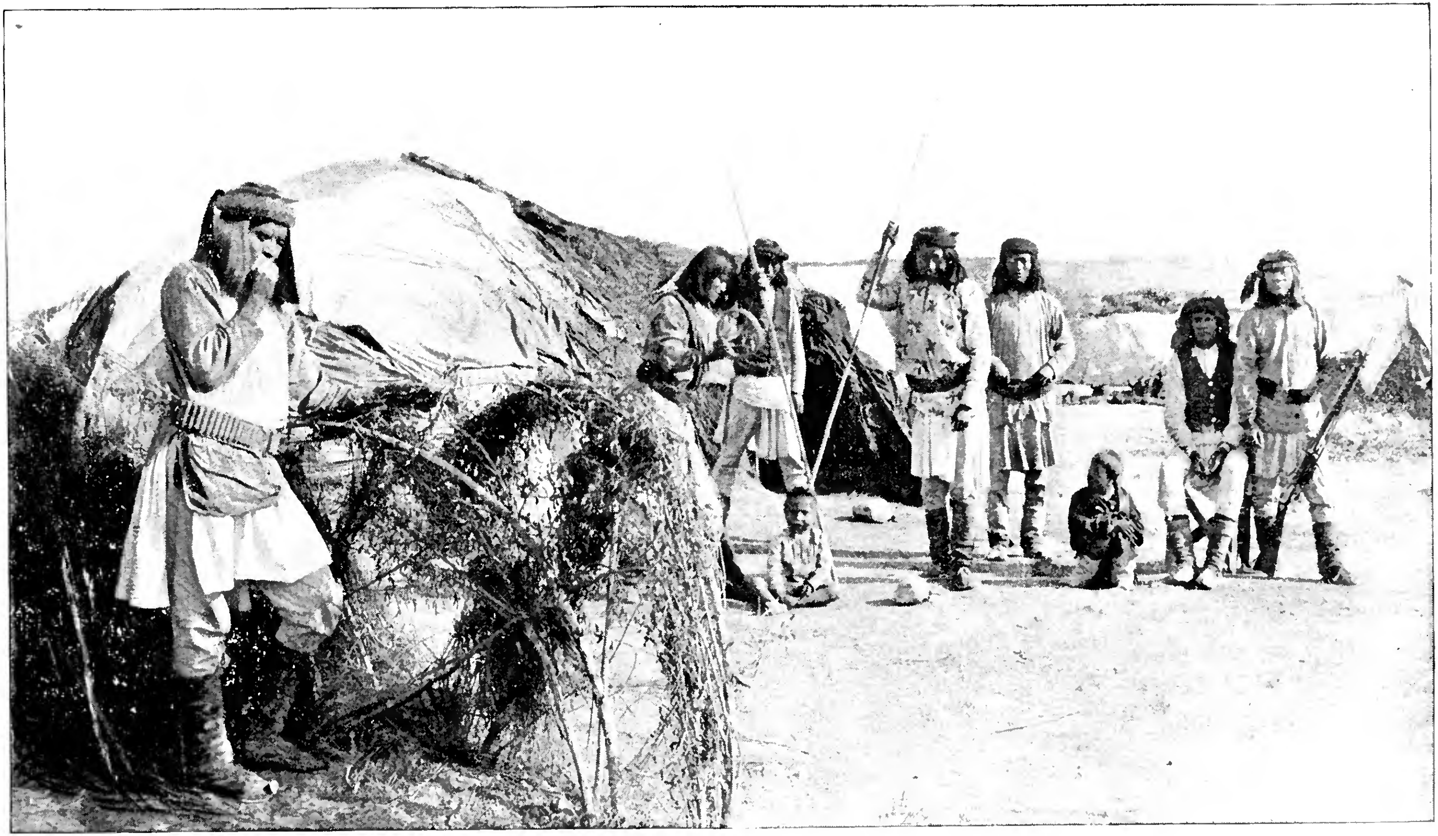

Fig. 1.—Apache Camp in Arizona.

feet in diameter. To make one, a hollow space is excavated with sharp sticks and their hands, and the earth is banked up around the circumference until they have a bowl-shaped depression about a foot and a half deep. Around the edge of this, bushes or branches of trees are stuck, bent over and fastened together to form a round top. In winter it is thatched with grass, *tule*, or soap-weed, so that it will shed rain. An opening is left on one side, which serves as an outlet for smoke as well as a doorway. The fire is made just inside the opening. For a bed they break up the ground, let it dry, pick out the stones, and then spread down dry grass. Seeds, meat, buckskins, extra clothing, etc., are hung outside on upright poles. Formerly only a few huts were usually found together, and they were occupied by members of one family, as these people had to scatter over the country in small parties and move frequently in order to obtain a sufficient supply of food; but in seasons of plenty, villages of about one hundred souls would be formed, when the huts of each family were always built in a group by themselves."

As primitive as these dwellings now are, they were found to be somewhat more so by Lieutenant Whipple in 1853, and he reports that "an Apache wigwam is as rude, it is believed, as any race of human beings have been known to construct for abodes. These huts are usually isolated in some mountain gorge, near a rivulet or spring, and are composed of broken branches of trees. They are covered with weeds, grass, or earth, such as may be obtained most readily. A large flat or concave stone, upon which they grind corn or grass seed to flour, is the only utensil or article of furniture that they do not remove in their wanderings. Visits to the houses of Mexicans or their more enterprising Indian neighbors excite no desire to improve their condition by the erection of more comfortable habitations. Tents they do not use, even when robbed from Mexicans or some poor party of emigrants surprised and murdered. The Tontos, Yampais, and most of the Apache Indians within New Mexico and California are equally barbarous and rude in the construction of their habitations."

Those curious people, the Havesu-pai Indians, living in a great, deep cañon in Arizona, also build lodges of rushes and limbs, but they are rather more substantial than those I have described for the Navajos and Apaches. This is due to the fact that they use rough timber uprights, and a few stout pieces for rafters. Their houses are also more commodious, although they rarely contain more than the one large living-room.*

* Shufeldt, R. W. Some Observations on the Havesu-pai Indians. Proceedings of the United States National Museum. Vol. xiv, pp. 387–390. Plates XXV and XXVI of this paper show the plans of the houses constructed by these Indians. Washington, 1891.

In my opinion, the next step taken in advance is by the Mojaves of Arizona, and those Indians build for themselves homes which are more or less permanent dwellings. One of these is shown in Fig. 2, and its architecture is certainly very remarkable. The upright portion of the frame is composed of very heavy timbers, each piece being completely stripped of its bark and firmly implanted in the ground. The rafters and the frame and ridge-piece for them to rest upon are also of timber much stouter than is at all necessary to support the roof. This

Fig. 2.—Style of House built by the Mojave Indians in Arizona.

latter is composed of long prairie grass overlaid with a thick coat of mud-plaster. It is quite impervious to the rain, and the eaves at one side are not more than a foot and a half above the ground. Indeed, the peak or ridge of this house is hardly as high as an ordinary man's head. All the sides and the front are left open, but the back is usually built up with timber and filled in with mud-plaster, or sometimes these Indians build this kind of an abode into an embankment at its rear. Internally it is not partitioned off into rooms at all, and the right-hand side of the dwelling constitutes a sort of a porch or wing, wherein the roof is horizontal, being much thicker than it is over the gabled portion. The floor is kept hard and clean inside, and most of the domestic arrangements are carried on in the open air. It will be observed that they have a lot of corn drying in a heap up on the roof, and their pottery utensils are in front outside.

Formerly it would appear that these Mojaves built a somewhat better home for themselves than this, and Lieutenant Whipple has said,* in reference to the figure of one he published in his report, that "the large cottonwood posts, and the substantial roof of the wide shed in front, are characteristic of the architecture of this people. This particular house appears to run into a sand-bank, and is peculiar. Others are formed in the valley, with all their walls supported by posts; and the longitudinal beams have their interstices filled up with straw or mud-mortar." . . . . The interior of a house consists of a single room with thatched roof, sandy floor, and walls so closely cemented by mud as to be nearly air-tight. It has no window, and receives no light except by the door which leads to the shed, and by a small hole at the top which gives egress to the smoke of fires. Structures similar to this are common throughout the lower portion of the Colorado Valley, and may be found also among the Coco-Maricopas and Pimas of the Rio Gila. With the latter, however, the circular hut, described by Mr. Bartlett, is much in vogue. In such gloomy abodes the Indians seek shelter from cold. Arranged around the walls are large earthen jars, in which they preserve their main supply of fruit and vegetables." Mojaves wear scarcely any clothing, especially the men, as may be seen from the individuals shown in my figure.

The more nomadic tribes of Indians, such as the Sioux of the North and others, when they come to build anything better than a *tepee*, erect a regular wigwam, a large, commodious structure of a conical form, supported by the cut trunks of saplings, and covered with ornamented or non-ornamented tanned buffalo-hides. Frequently I have been in one of those wigwams, and at almost any time of the year they are very comfortable, though rather warm in summer. All the buffaloes now being practically exterminated, those tribes which formerly built hide wigwams will now have to resort to the construction of other kinds of homes. Probably they will do as the Navajos have done, and come to erect houses more or less like the primitive one-room buildings of the early squatters. Navajos, however, place the timbers side by side in the vertical position, filling the interstices with mud-plaster, whereas, as we know, in the ordinary log-cabin they are laid one on top of another in the horizontal method, with

* Pacific Railroad Reports, vol. iii, p. 23, (1853–'54).

their ends molded upon each other by the aid of an axe, or an adz. The Choctaws have long built such houses, and the more intelligent tribes of the Indians on our frontier will undoubtedly follow their example, as they become completely surrounded by our advancing line of civilization.

From this point, did the scope of my article admit of it, I should like to show how, from such houses as have thus far been described, we pass through easy transitional stages to the higher types of architecture, or the communal homes of the Indians of the pueblos of New Mexico and Arizona. Such a treatise, however, would form quite a volume, and far exceed my limits.

In those transitional stages to which I refer, it can be shown that a great many interesting forms of homes are built, or

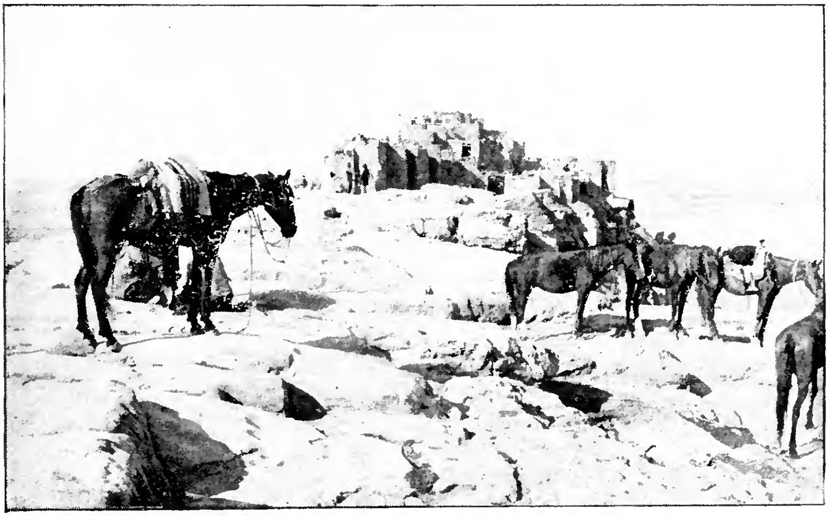

FIG. 3.—WOLPAI, A MOQUI INDIAN VILLAGE.

used to be built, by the Indians. These present every imaginable form: in some the thatching is very well done, and very ingenious; in some the door is at the side, while in others it is on the roof; they contain single rooms, as well as rooms *en suite*; and finally they gradually pass from the use of brush, poles, hides, and mud-plaster to the employment of *adobe*-plaster, rubble-stone, and *adobes*. Mr. Lewis H. Morgan has said that "a comparison will show that they belong to a common indigenous system of architecture. There is a common principle running through all this architecture, from the hut of the savage to the commodious joint-tenement house of the village Indians of Mexico and Central America, which will contribute to its elucidation."* And in the same work this distinguished author adds that the same common principle runs through all this Indian architecture, "from the 'long house' of the Iroquois to the 'pueblo houses' of New Mexico, and to the so-called 'palace' at Palenque and the 'house of the nuns' at Uxmal. It is the principle of adaptation to *communism in living*, restricted in the first instance to household groups, and extended finally to all the inhabitants of a village or encampment by the *law of hospitality*. Hunger and destitution were not known at one end of an Indian village while abundance prevailed at the other. Joint-tenement houses, each occupied by one large household, as among the Iroquois, or by several household groups, as in Yucatan, were the natural and inevitable result of their usages and customs. Communism in living, and the law of hospitality, it seems probable, accompanied all the phases of Indian life in savagery and barbarism."

Several years ago the present writer visited the pueblo of Zuñi in New Mexico, and I have seen some of the others, as well as the ruins of a number of the ancient ones. Both New Mexico and Arizona to-day offer a rich field for the investigations of the thoughtful, scientific anthropologist, for in many localities in each Territory he will not only find, in all stages of preservation, the old ruins of the almost extinct "cliff-dwellers," the remains of former pueblos; but he will likewise have the opportunity of comparing the previous states of those communal villages with several of them still in existence. There are about twenty pueblos in New Mexico that are still inhabited, and in Arizona we find seven more that constitute the Moqui group. Many of these have been studied by members of several of the Government exploring parties, and by other individuals, but there still remains a vast store of knowledge in regard to them that no one has as yet drawn upon. This to be done at all must now be done quickly, for our own civilization presses closer upon them each year that goes by, and will very soon work its invariable changes.

Some of these pueblos are built out upon the level, open plain, several miles from any high or mountainous land, and are usually near some river-course, as in the case of Zuñi or Santo Domingo; or they may cap the extremity of some bold *mesa*, five or six hundred feet above the surrounding prairie, as is the case with the Moquian pueblo, Wolpai (Fig. 3).

Substantially their plan of structure is the same, though it may differ considerably in detail, and this likewise applies to the

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* Houses and House-life of the American Aborigines. Department of the Interior, United States Geological and Geographical Survey of the Rocky Mountain Region. Washington, 1881, pp. 104, 105.

mode of life of their inhabitants. Massed together and built of *adobes* of rock laid in mud-mortar, and reared in tiers or terraces of from two to three or more stories high, they admirably fulfill

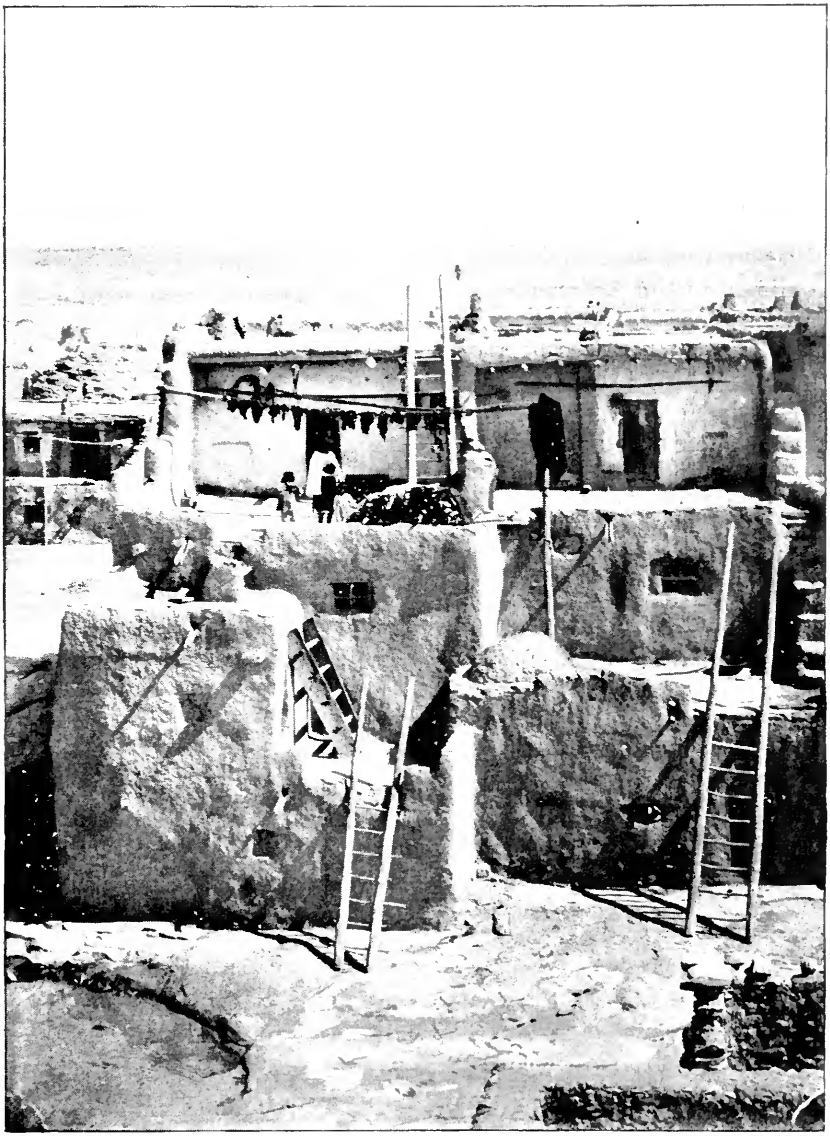

Fig. 4.—Terrace Houses in the Pueblo of Acoma, New Mexico.

the triple purpose of a durable architecture, a communistic plan of living, and as a fortress in the event of an attack from outside marauders.

Many of the pueblos, now in ruins, were at the time of Coronado's expedition to New Mexico, in 1541–1542, at the height of their vitality, and a study of a number of these go to show that in their arrangement they were built upon some definite plan. Their ground plans point to the fact that they were laid out upon the quadrate of a circle in some instances, while in others the three sides of a parallelogram were chosen, or roughly the arc of a subellipse, the major axis joining the extremities, and represented by a double tier of houses. In other cases the entire ellipse can be traced from the ruins, but houses were not erected on the lines of its axes, as was the plan in Pueblo Peñasca Blanca. Most of these and the more elaborate ones are found upon the Rio San Juan and its tributaries; others are seen upon the Rio Animas, in the cañon of the Rio de Chelly, in the Ute Mountains, and elsewhere.

Of the pueblos yet inhabited the best examples are seen in the Moqui group, in Zuñi, Acoma, Santo Domingo, and Laguna. Apart from the demoralizing influences of the Roman Catholics upon some of them, and the changes brought about by our civilization, these pueblos may be taken as fair examples, though by no means of the highest type, of what existed in the country at the time of the discovery. All these tribes have been termed the sedentary Indians, and they enjoy a sort of crude civilization of their own: engage in agriculture, make pottery, weave blankets and many garments of wool, and have many other simple arts and industries. They are the descendants of the inhabitants of the ancient pueblos discovered by Coronado, and in many instances are occupying, in the present villages, houses which certainly are as old as his time. Their government, religious rites and ceremonies, their dances and customs, habits and dress, and domestic life are all full of the greatest interest, but can not properly be treated in the present contribution.

My view in Fig. 2 of some of the houses in the pueblos of Acoma, New Mexico, shows very well their structure and arrangement. It will be seen that they are built in three tiers or terraces, one on top of another. The material used is *adobe* cobblestone flakes gathered from the country about, and laid in *adobe* or mud-mortar. The roofs are made of cedar rafters, hewn and brought in by the men, who also fetch in most of the stone material. Plastering, however, is done by the women, who puddle the mud and lay it on with their hands. While thus engaged, its consistency is regulated by their squirting water upon it, which they take into their mouths for the purpose. It will be observed that the lower stories of houses have few or no entrances, and this is undoubtedly for the purpose of defense. Their roofs form the terrace to the second tier, which is reached by the means of ladders.

Sometimes, too, the partitions or vertical walls between the houses are extended upward, and externally are formed into steps, each step being made by a slab of stone as seen in the figure. Ladders are also used to reach the other terraces, as well as the roof that tops the whole of this human bee-hive. In Zuñi I found doors opening from the street directly into the rooms of the ground-floor, and there were many hatchways in the roofs, the rooms below being reached by the means of ladders, such as the long ones shown in my picture of Acoma. Chimneys are built up with stone and mortar, and frequently are topped off by a large clay *olla* set in the latter, after having its bottom knocked out so as to give egress to the smoke from the stone fireplace found in so many of the rooms.

Small windows with four panes each admit a meager light to the interior of these dwellings. These panes are most often composed of mica obtained in the mountains, but of recent years they have not infrequently obtained glass from the whites suitable for the purpose, and they always prize that material very highly. Rain which accumulates on the several roofs during the continuance of storms, finds its escape at guttered apertures supplied with small troughs, shown in the engraving. Often a dome-shaped oven is built out on the roof in one of the angles, and in this they bake their bread. One of these is also shown in the picture, and at Las Nutrias Pueblo, in New Mexico, I saw that they built these ovens out on the ground, and were baking *tortillas* in them at the time of my visit.

One of these pueblan houses rarely has less than three rooms, and may contain as many as eight or nine. Most of those that I have been in—and I have been in a good many of them—are kept scrupulously clean and neat. Their repair devolves entirely upon the women, who consider it their especial prerogative. The floors are evenly laid in moistened clay, and when that material dries, an excellent surface is the result, hard and smooth. They make a kind of whitewash of gypsum, with which the smoothly plastered walls are kept constantly white.

The ceiling overhead is composed of a generous supply of stout rafters of cedar that run horizontally across from wall to wall, and at Zuñi, the Indians had filled in the interspaces with osier brush, covering the outside or roof with a heavy layer of *adobe*-plaster. Often an entire family is confined to one large room, or, if better circumstanced, they may control two or even more.

Conspicuous among its finishings in the living-room are the arrangements to do the family cooking. Sometimes the fireplace, built of the usual masonry, is fitted into one of the angles of the room; sometimes it juts out at the middle of the long side of the apartment; in either situation the chimney, smaller in its dimen-

Fig. 5.—Scene in a Court-yard of Laguna Pueblo, New Mexico. (The corn-dance in progress.)

sions, rests by its base on its horizontal upper plane, leaving always a mantel-shelf all round. In front of either one of these we find the contrivance upon which they bake their tissue-bread or *waiavi,* and projecting out above it the hood which conducts the smoke into the chimney. This contrivance is nothing more than an oblong stone slab, as smooth as polished glass upon its upper surface, and raised on four legs at its angles about a foot and a half above the cemented floor. Beneath this glowing embers are raked in sufficient quantity to keep the slab hot, and it thus answers its purpose admirably.

"In Zuñi, as elsewhere, riches and official position confer importance upon their possessors. The wealthy class live in the lower houses, those of moderate means next above, while the poorer families have to be content with the uppermost stories. Naturally no one will climb into the garret who has the means of securing more convenient apartments, under the huge system of "French flats," which is the way of living in Zuñi. Still, there is little or no social distinction in the rude civilization, the whole population of the town living almost as one family. The alcade or lieutenant-governor furnishes an exception to the general rule, as his official duties require him to occupy the highest house of all, from the top of which he announces each morning to the people the orders of the governor, and makes such other proclamation as may be required of him." *

There is one other prominent object in the living-room of a Zuñian home which we can not afford to overlook in the present account. I refer to the troughs in which they grind their corn, and Mrs. Stevenson, whom I have just quoted, gives an excellent account of one of these. She remarks that "the pueblo mills are among the most interesting things about the town. These mills, which are fastened to the floor a few feet from the wall, are rectangular in shape, and divided into a number of compartments, each about twenty inches wide and deep, the whole series ranging from five to ten feet in length, according to the number of divisions. The walls are made of sandstone. In each compartment a flat grinding-stone is firmly set, inclining at an angle of forty-five degrees. These slabs are of different degrees of smoothness, graduated successively from coarse to fine. The squaws, who alone work at the mills, kneel before them and bend over them as a laundress does over the wash-tub, holding in their hands long stones of volcanic lava, which they rub up and down the slanting slabs, stopping at intervals to place the grain between the stones. As the grinding proceeds the grist is passed from one compartment to the next until, in passing through the series, it becomes

* Mrs. James Stevenson, in Lewis H. Morgan's report, cited above.

of the desired fineness. This tedious and laborious method has been practiced without improvement from time immemorial, and in some of the arts the Zuñians have actually retrograded." *

The above is a faithful description of one of the pueblan mills; I observed a great many of them at Zuñi, and elsewhere have said that I "saw standing behind one of the stone slabs where they grind their corn, a pretty Zuñi girl, not a day over a year old, and as naked as the hour she was born, with the stone grinder in her hands, playfully showing her mother, who watched her with no little pride in her face, how to grind the corn. The picture was a charming one, and if the expressions of all could have been caught at the proper moment, what a study it would have made!" †

The tiers of houses at Zuñi, in common with a number of the other New Mexican and Arizonian pueblos, are clustered about two open squares or public plazas of no very great size, a portion of one of them being used as a graveyard in front of the abandoned mission church in Zuñi. In Fig. 5 of the present article I give the court at Laguna Pueblo of New Mexico, which is there kept clean and neat. This picture well shows the arrangement and relation to each other of these conglomerate homes. In this engraving the annual "corn-dance" of the Lagunas is being performed—a very interesting ceremony.

Thus in the present account I have passed briefly in review the study of the homes which the American Indians build for themselves in these days. The subject could easily be enlarged upon, and, indeed, treated in detail, would fill three or four ample volumes. My labor, however, will have been well repaid should it be the means of inciting the student in anthropology, with a knowledge of the present literature of the subject, to broaden the field by published accounts of his or her own observations. Much yet remains to be carefully studied and compared, much that is yet obscure or totally unknown to science. It must be done in the near future, for already many of the facts are rapidly fading upon the unturned pages of aboriginal American history.

The forests of Chaga, the temperate zone of Mount Kilimandjaro, Africa, as described by Dr. W. L. Abbott, have a most curious appearance. The trees, although often of very thick trunks, are not tall but somewhat stunted. The trunks and larger branches are completely covered with orchids, lichens, ferns, and moss. From every limb and twig hang long festoons of gray moss, while the ground is thickly carpeted with ferns of a species resembling "love in a tangle." Some of the huge tree-trunks are perfect botanical gardens, from the number and variety of the plants growing upon them.

* Lewis H. Morgan's report, p. 140.

† Shufeldt, R. W. Zuñi as it is. Forest and Stream, New York and London, July 2, 1885, pp. 446–448.

RECENT SCIENCE.

By P. KROPOTKIN.

I.

THE world of chemical phenomena is so immensely wide, and the phenomena themselves are so complicated, that the founders of modern chemistry were compelled to limit the area of their investigations, and sharply to separate their own domain from those of the two sister-sciences, physics and mechanics, leaving it to the future to find out the bonds which might unite all three branches into one harmonious whole. They and their followers elaborated their own methods of investigation; they discovered their own chemical laws and worked out their own hypotheses and theories; and, with the aid of these methods, laws, and hypotheses, they created a science which not only interprets, discovers, and predicts the phenomena it deals with, but already has brought us within a measurable distance of a general theory of the structure of matter altogether.

In proportion as chemical research went deeper into the study of the wonderful movements and interactions of molecules and atoms, the intimate connection which exists between chemistry, physics, and mechanics became more and more apparent. The physical and the chemical properties of matter proved to be so closely interdependent that they could be explained no longer with the aid of chemical theories alone; the very fundamental laws of chemistry appeared to be but so many expressions of physical facts; and chemistry stands now in such a position that no further advance in its theoretical part is possible, unless it enters the border-land which separates it from physics, recognizes the unity of chemical and physical forces, and, availing itself of the progress recently made in molecular mechanics, boldly attacks the great problem of a physical—that is, a mechanical—interpretation of chemical facts. This is the work which now engrosses the attention of most chemists.

The points of contact between physics and chemistry are very numerous, and the work is being carried on in several directions at once. The discovery by Mendeléeff of the so-called "periodical law of elements" has called into life numerous researches, some of which accumulate correct numerical data to express the dependence between the physical properties of various bodies and their chemical constitution; while others endeavor to interpret this very periodicity in the properties of the elements under the assumption of their compound nature. On the other side, the recent development of the mechanical theory of heat, and the interest awakened of late in electricity, have given rise to numerous researches aiming at a representation of chemical reactions as mere transformations of heat-energy or electricity. And, finally, most skillful investigations are being made, and most suggestive hypotheses advanced as regards the possible distribution of atoms within the molecules, under the supposition of their remaining in a state of equilibrium; and thus the way is prepared for a higher conception of the atoms—not motionless and mutually equilibrated, but involved, like the planets of our solar system, in complicated movements within the molecules. Works of importance have appeared of late in each of these directions. But no other domain has lately been explored with such a feverish activity as the vast domain of *solutions;* and to these researches we must now turn our attention.

In former times it was supposed that if some table-salt or sugar (or any other solid, liquid, or gas) is dissolved in water or in any other liquid, the particles of the dissolved body will simply spread, or glide, between the particles of the solvent, and simply be mixed together—just as if we had made a mixture of two different powders or two gases. But on a closer study a succession of most complicated and unexpected phenomena was revealed, even in so simple a fact as the solution of a pinch of salt in a tumbler of water. The solutions proved to be the arena upon which phenomena cease to be purely physical, and become chemical, and they were studied accordingly with the hope that they might give a physical cue to chemical reactions. Hundreds of researches are contributed every year to this subject;* and although there is yet no final result to record, we are bound nevertheless to examine the present state of investigations which so much interest and excite chemists.†

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* The committee appointed by the British Association for reporting on the bibliography of solutions had catalogued no less than 255 papers, which appeared in 1890, in a few periodicals only. The total was at that time 930 papers.

† We know no general review of this extremely complicated question which we might recommend to the general reader. The address delivered by Prof. Orme Masson before the Australasian Association for the Advancement of Science, in January, 1891; Prof. S. U. Pickering's Report to the British Association, in 1890, on the hydrate theory of solution, followed by a most interesting discussion between Profs. Gladstone, Arrhenius, Armstrong, Fitzgerald, Van 't Hoff, Lodge, Ostwald, and Ramsay, and the elaborate report, by W. N. Shaw, on electrolysis (British Association Reports, 1890, Leeds), are excellent sources of general information. Ostwald's work, Solutions (English translation in 1891), as well as his Lehrbuch der allgemeinen Chemie (Leipsic, 1885; new edition of first volume in 1892), and the review, Zeitschrift für physikalische Chemie, which he publishes since 1887, unhappily take but little notice of the chemical aspects of the question. Mendeléeff's foot-notes in his most remarkable Principles of Chemistry (London, 1891) are perhaps, on the whole, the best means for gaining a general and impartial insight into the whole question. Though himself one of the earliest promoters of the hydrate or chemical theory of solutions, he

Few scientific hypotheses have proved so productive in the development of science altogether as the so-called "kinetic theory of gases." A gas, according to this hypothesis, is an aggregate of molecules which move very rapidly in all directions and endeavor to disperse in space—the rapidity of their movements being increased by every increase of the temperature of the gas. In their endeavors to escape in all directions the molecules of the gases continually bombard the walls of the vessels which contain them. They break them if they are weak enough, or else they exercise upon them a pressure which is nothing but the sum of all energies of the molecules which strike a unit of surface in a unit of time. In our steam-engines the molecules (or rather particles) of steam bombard the walls of the cylinder; they push the piston by their aggregate energies, and, setting it in motion, make it move the huge masses it has to move. This is, of course, but a hypothesis; but since it so perfectly explains the pressure, the elasticity, the diffusion, and the internal friction of gases, and permits us to predict the consequences of the invisible bombardment; and since its consequences, mathematically deduced by Maxwell, Clausius, Boltzmann, and many others, fully agree with the reality of facts—it can be considered no more as a mere guess: it is a theory.

Now, the Dutch chemist Van 't Hoff proved in 1886 that the same theory holds good for weak solutions as well. If some sugar, or some sulphuric acid, or any other liquid or solid, be dissolved in some liquid, the bonds which keep together the particles of sugar or of the acid are torn asunder by the solvent. The particles spread among those of the solvent, and they take up the same movements which they would perform if the sugar or the acid were brought into a gaseous state in a free space. They bombard the walls of the vessel, and exercise upon them a certain pressure which will be increased if the bombardment is rendered more violent by either raising the temperature of the solution, or increasing the number of bombarding particles by a limited increase of its strength. Though there is not the slightest reason for supposing that the dissolved solid or liquid may be in a gaseous state within the solvent, the very fact of scattering its particles over a broad space is sufficient to free them from their mutual bonds; they behave exactly as if the sugar or the acid were brought into a gaseous state by evaporation and filled the space occupied by the solution. They obey all the physico-chemical laws (the laws of Boyle, Marriotte, Gay-Lussac, and Avogadro) which hold good for gases.

The kinetic theory of *gases* was thus extended to *liquids*, and

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fully recognizes the importance of the physical theories, and sums them up with his usual clearness.

this first step was soon followed by another, even more important step, when Van der Waals—also a Dutch chemist—still more effectively bridged over the gap between the gaseous and liquid condition of matter. He studied that state of a gas when, under an increasing pressure and a decreasing temperature, it becomes a liquid; and he found a mathematical expression (an equation) which very approximately represents the mutual dependence between the volume occupied by the gas under a given pressure, its temperature, the volume occupied by its particles, and their mutual pressure. He thus expressed in a more comprehensive way how, in proportion as the lengths of the paths of its particles decrease, a gas becomes a liquid.*

The long-since suspected continuity between the gaseous and liquid states of matter was thus demonstrated once more, and rendered easy to investigate; and the importance of these conclusions was still more enhanced by Clausius, when he demonstrated that a slight alteration of Van der Waals's equation makes it also represent the absorption or dissipation of heat-energy which always takes place when a body passes from the liquid to the gaseous state, or *vice versa*.

And, finally, another step in the same direction was made by the French physicist, Raoult. We all know that if some table-salt, or saltpeter, or some other salt, be added to water, the water may be cooled below zero without freezing. Its freezing temperature is lowered. Now, Raoult studied the lowering of this temperature caused in water and other liquids by the addition of various amounts of various salts, and he came to a most remarkable result. It appeared that, whatever the nature of the dissolved salt may be, the freezing temperature of a solution will always be lowered by the same amount (nearly six tenths of a degree) if we add one molecule of the dissolved body to each hundred molecules of the solvent.† Thus, again, a purely physical fact, such as freezing, proves to be dependent upon a purely chemical fact—the molecular weights of the solvent and the dissolved body; and this physical law is so general that it has become a very accurate means for determining such chemical data as molecular weights. Chemistry and physics appear again so closely interwoven that there is really no means of separating them.

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* See the interesting discussions which took place upon this subject in the Physical Society, in October and November last.

† Thus, if table-salt be used, the weight of its molecule (compared with a molecule of hydrogen) is $58\frac{1}{2}$; while the weight of a molecule of water (also compared with hydrogen) is 18. So that, if we add $58\frac{1}{2}$ ounces of table-salt to each 1,800 ounces of water, we shall lower its freezing temperature by 0·62° of the centigrade scale. The same result will be obtained if we take $74\frac{1}{2}$ ounces of potassium chloride, or 101 ounces of saltpeter, to the same amount of water.

It is not possible to describe in a few words the impetus given by the discovery of these connections to physico-chemical research altogether. A school, headed by Ostwald, of most enthusiastic supporters of what has been termed (not quite properly) the physical theory of solutions, has grown up; and this school, while bringing out a mass of important researches and widening the field of chemical investigations, has naturally come to consider itself as being on the right track for elaborating a complete theory of the subject. Unhappily, this is not the case, because the chemical reactions which undoubtedly take place in solutions are not taken into account in the just-mentioned physical laws. In reality, so long as but small amounts of solids, or liquids, or gases are dissolved in a liquid, and so long as only such bodies are brought into contact as have no strong chemical affinity for each other, the above theories are quite correct. But as soon as the solution is rendered stronger, or the solvent and the dissolved body are endowed with a mutual chemical affinity, chemical reactions set in. Part of the molecules of the dissolved body dissociate, and the atoms of which they were composed, on being set free, combine with the atoms of the solvent. Chemical forces, much more energetic than the physical forces, enter into play, and most complicated chemical reactions—the intensity of which may be judged of from the changes of temperature—begin. To deny them is simply impossible, although this has been done in the excitement of polemics. The chemical reactions which take place within the solutions, and especially the formation of definite though unstable compounds of salts, acids, and bases with water, have been rendered evident by so many careful investigations of experienced chemists,* that the secondary importance given to them by most adherents of the physical theory would be simply incomprehensible were it not for the hope which they cherish of ultimately explaining all chemical processes by the above-mentioned molecular movements. At any rate, in order to account for the effects of the chemical reactions, the followers of the physical theory were compelled to seek support in an additional agency—electricity. Starting from the familiar fact of solutions being decomposed by an electrical current, they admitted that in every solution part of its molecules dissociate, breaking up into their component parts, which are charged with either positive or negative electricity (the name of "ions" is usually given to those component parts). By means of this admission, they attempted to explain the discrepancies between observation and the conclusions drawn from the above-mentioned laws,

* We need only mention the names of Armstrong, Etard, Pickering, Mendeléeff, and so on.

especially in the case of water solutions of salts, acids, and bases, and the stronger solutions altogether. It must be recognized that many important relations between electrical conductivity and chemical action have been brought out in this way by Arrhenius * and his followers, and many discrepancies between the laws of Van 't Hoff and Raoult and the observed facts have been explained. But it is also evident that, once a partial dissociation of molecules is admitted, the whole takes a chemical aspect, and reference to such an unknown cause as electricity does not simplify the matter. All kinds of chemical reactions take place in solutions. Some molecules of the dissolved body simply exchange their atoms in succession, while maintaining the same grouping of atoms, and consequently the same chemical composition. In other molecules the grouping only of the same atoms is changed, and we have reactions of replacement, or isomerism. But, at the same time, new and more or less stable combinations between the atoms of both solvent and dissolved body take place in various proportions; double decompositions most probably occur as well; while the physical phenomena of sliding of undecomposed particles continue at the same time—the *physical* movements of the particles being impressed by, and acting upon, the *chemical* movements of the atoms within the molecules.

It must be confessed that neither theory has as yet succeeded in following this multitude of movements and of catching the moment when the movements of particles are transformed into atomic movements and redistribution; and though we may name several equally important works which have been published on this subject during the last twelve months, we can mention none which have thrown new light on the subject.† Let us only add that the subject itself has been immensely widened of late by the wonderful researches of Heycock and Neville on the lowering of the temperature of solidification of metals, by the addition of other metals, and of Roberts-Austen upon alloys—that is, metals dissolved in metals—which behave very much like all aqueous solutions. However, a new departure in this branch has been made, quite recently, by Messrs. Harold Picton and S. E. Linder. They studied the structure of solutions of sulphide salts which offer the advantage of giving a whole series of gradations between real solutions (that is, liquids which seem to consist of liquid particles only) and such as contain extremely small particles of solid matter in suspension. By submitting the series to various tests, it

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* Svenska Vetenskaps Academiens Handlingar, 1863.

† Besides the leading chemical periodicals, an excellent analysis, by W. Nernst, of all the chief work done during the year 1891, and its bearing upon the theory of solutions, will be found in a chemical year-book which was started this year by Richard Meyer, the Jahrbuch der Chemie. Frankfort, 1892.

was ascertained that all these solutions, even those reputed as homogeneous, contain infinitely small solid particles, the presence of which is revealed, on Tyndall's method, by a beam of light. In some of them the particles—all of the same size and performing rapid oscillatory movements—are even seen under the microscope, when magnified a thousand times; while in antimonium sulphide the very formation of coarser agglomerations out of invisible particles can be followed under the microscope. In short, the authors came to the conclusion that there is no sharp limit between a state under which the mutual attractions between the particles of the solvent and the suspended particles of the dissolved body are very feeble, and a state when, these aggregations becoming of a smaller size, the forces which keep them in the solution become of a decidedly chemical nature. A new and promising method is thus given.

If we take into account the rapid accumulation of data relative to the subject of solutions and the various theories already germinating, we may hope that the day is not far off when a complete theory of these phenomena will be possible. Let us only remark that all the work hitherto done confirms more and more the idea which becomes more and more popular among chemists, and which Mendeléeff has so well expressed in a lecture delivered before the Royal Institution in May, 1889;* namely, that the molecules of all bodies, simple or compound, borrow their individualities from the characters of the movements which the atoms perform within the molecules. Each molecule may be considered as a system, like the systems of Saturn or Jupiter with their satellites—each separate type of such systems giving a separate type of molecules, and the chemical properties of the molecules being determined by the character of the system and its movements. It may already be foreseen that further progress in the great investigation into the mechanical basis of chemical energy will be made in this direction.

II.

One of the chief objections to the theory of evolution which was especially laid stress upon some thirty years ago, was the impossibility of producing at that time a series of "intermediate links" to connect the now existing animals and plants with their presumed ancestors from former geological epochs. To meet the objection, Darwin had to devote a special chapter in his great work to the imperfection of the geological record, and to insist both upon its fragmentary character and our imperfect knowledge of what it contains. The recent progress of both geology

* An attempt to apply to Chemistry one of the Principles of Newton's Natural Ph losophy, in the Principles of Chemistry, vol. ii, Appendix I.

and paleontology renders such explanations almost superfluous. Geology, aided by the deep-sea explorations, has come to a better comprehension of the mechanism of sediments, and it knows what it may expect to find in the rocky archives of the earth, and what it may not; and, on the other side, the discovery of the missing links between past and present has been going on of late with such a rapidity as has outstripped the most sanguine expectations. Our museums already contain whole series of fossil organisms which almost step by step illustrate the slow evolution of large divisions of both animals and plants; our present mammals already have been connected by intermediary forms with many of their Tertiary ancestors; and the paleontologist can already trace the pedigree of birds, and even mammals, as far back as the lizards of the Secondary period—not merely deducing it from embryological data, but by showing the real beings which once breathed and moved about upon earth.

At the same time one point of great moment for the theory of evolution, and only alluded to by Darwin, has been brought into prominence. The part played by migrations in the appearance of new species has been rendered quite obvious. Thus we know perfectly well that the ancestors of our horse migrated over both Americas, Asia, Europe, Africa, and probably back to Asia, and that each step in those migrations was marked, by the apparition of some new characters which are now distinctive of the horse. The same remark applies to the mastodons and their descendants, the elephants; to the common ancestors of the camel and the llama, and to the Ungulata altogether. It may be taken now as a general rule that the evolution of new species chiefly took place when the old ones were compelled to migrate to new abodes, and to stay there for a time in new conditions of climate and general surroundings. The intermediate forms have *not* been exterminated on the spot; and if we want to obtain the intermediate links between two allied species, the relics of which are found in two geological formations of a given country, we must ransack for fossils all the five continents upon which the intermediate links have been scattered. This is why the discovery of intermediate types has gone on so rapidly since North America, South Africa, South America, New Zealand, and partly Asia began to be thoroughly explored by experienced paleontologists.

Many of the "missing links" were discovered, as is known, in Darwin's lifetime. Thus, the first really bird-like, feathered lizard, the *Archæopterix*, was unearthed as early as 1862; and eight years later, Prof. O. C. Marsh already described, from the Upper Cretaceous beds of North America, two more lizard-birds, one of which (*Hesperornis*) must have resembled our present fish-eating divers, while the other (*Ichthyornis*), provided with powerful wings, had—apart from its teethed jaws—all the appearance of a bird of our own time.* And, finally, the discovery of a large ostrich-like bird (*Dasornis Londinensis*) in the Lower Eocene of the isle of Sheppey, and of another, also big and flightless bird (*Gastornis*), in the Eocene of Meudon, Rheims, and Croydon, established a further connection between the bird-like lizards of the Triassic times and real specialized birds.

These last discoveries brought the series very near to our own times, and they were the more valuable as the just-mentioned *Gastornis* proved to combine some of the characters of both flying birds and of those which, like the ostrich, the cassowary, and the emu, do not fly; while the Pliocene deposits of north India and the numberless remains of the so-called *moas* of New Zealand yielded specimens of still nearer ancestors of our flightless birds. The New Zealand deposits of bones became known more than fifty years ago, when Owen, on receiving (in 1839) a broken but characteristic moa bone, determined the general characters of the great ostrich-like *Dinornis*, which inhabited the island quite recently, but is found no more in a living state. But it is especially of late that the enormous accumulations of moa remains have been explored in detail. Cart-loads of those bones have already been shipped to Europe, and new accumulations continue to be found—always with the same astonishing numbers of individuals entombed on the same spot, and in the same excellent state of preservation. Such a deposit—one of the most remarkable of its kind—has been lately discovered by Prof. H. O. Forbes, near Oamaru, in the South Island of New Zealand. In a small hollow which did not exceed twelve yards in width, no less than eight hundred to nine hundred individuals were imbedded in solid peat, under a superficial layer of a few inches of soil. Many skeletons lay quite undisturbed, and in some instances the contents of the stomach, which consisted of triturated grass and small rounded and smooth quartz pebbles, were found lying in their natural position, under the sternum. The bones of a giant buzzard, a big extinct goose, the Cape Barron goose, the kiwi, and so on, were mixed together with bones and full skeletons of several species of *Dinornis*, big and small.† And again, as on previous occasions, the New Zealand scientists are at a loss to explain the accumulation of so many various birds on such a narrow space. However, the most interesting part of Prof. Forbes's dis-

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* R. Lydekker's Catalogue of Fossil Birds of the British Museum, London, 1892. For the general reader we can not but highly recommend a charming book of the same author, Phases of Animal Life, Past and Present, London, 1892, which is a real model of scientific and popular literature.

† Letter to Nature, March 3, 1892, vol. xlv, p. 416.

coveries is that he has finally succeeded in finding among this mass of bones one bone, at least, which bears unmistakable traces of having been connected with a humerus, the head of which must have been as substantial as in cassowaries. He thus considers it proved that the *Dinornithidæ*, like the kiwis, descended from birds which could fly.* The last missing link is thus discovered, and the chief points in the genealogy of birds are thus already settled, while many a gap which still remains will certainly be filled up when the rich materials recently excavated in both Americas have been carefully examined by anatomists.

The same may be also said in regard to mammals, if the recent discoveries in North and South America are taken into account. The earliest traces of mammals have been found, as is known, in the Triassic deposits of Germany, Basutoland, the Cape Colony, and North Carolina; and it is also known, through the previous remarkable works of Professors O. C. Marsh and H. F. Osborn, that the Jurassic deposits of Wyoming have yielded a rich fauna, among which we find the remote ancestors of various orders of the present mammalia.† But the most important finds, which throw a new light both on the earlier and the subsequent forms, have been made in that immense area of lacustrine beds which have been deposited in the region of the great salt lakes of Utah, Wyoming, and Colorado, from the end of the Cretaceous period down to the middle parts of the Tertiary epoch. There, and especially in the Eocene "Puerco" and "Wahsatch" beds, as well as in the Eocene "Uinta" formation, a rich fauna of mammals has been unearthed.‡ All those Eocene mammals had something in common in their leading features, and yet they offered a sufficient diversity for being considered as the probable ancestors of nearly all orders of placental mammals. To mention their feet only, they were adapted, in all of them, for walking upon the sole, and were provided with five toes; but it is easy to recognize in the structure of the feet of the different genuses such divergences as necessarily ought to evolve, under certain conditions—on the one side, the plantigrade foot of the bears, and, on the other side, the digitigrade foot of the Ungulata (horses, camels, elephants, and so on), who walk upon the points of their toes; and, again, among

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* Nature, 1892, vol. xlv, p. 257.

† O. C. Marsh, in American Journal of Science, 1888 to 1891; H. F. Osborn, The Structure and Classification of Mesozoic Mammalia, in Journal of the Academy of Natural Science of Philadelphia, vol. ix; R. Lydekker, Catalogue of the Fossil Mammalia in the British Museum, London, 1891.

‡ Cope's Synopsis of the Vertebrate Fauna of the Puerco Series, and W. Scott and H. F. Osborn, The Mammalia of the Uinta Formation, in Transactions of the American Philosophical Society, new series, vol. xvi, Parts II and III, Philadelphia, 1889. Also R. Lydekker's paper in Nature, vol. xliii, p. 177; and Phases of Animal Life.

these latter it is possible to find indications for an evolution which must have ended in the appearance of two divisions—the odd-toed and the even-toed ungulates. Most laborious anatomical researches were required for properly interpreting these rich materials. But the result of the work is that we already know with a great approach to certitude the genealogical trees of most ungulates; we can go back to the ancestors of the ruminants, the cameloides, the chevrotains, the horses, and even to the common ancestors of the whole group of ungulates; while the genealogy of other large groups of mammalia has also been worked out to some extent.

The just-mentioned discoveries in North America were soon supplemented by still more remarkable finds in South America, which finds follow each other with such a rapidity that anatomists will have to make strenuous efforts in order to keep pace with the paleontological work. The formation which D'Orbigny described as "formation guaranienne" proved to consist of marine Cretaceous beds, covered by immense land deposits, which, like the Laramie beds of North America, are of an intermediate age between Cretaceous and Tertiary. These last beds offer an immense interest, owing to their mammalian fossils (of much more specified types than those of the Laramie), which are mixed together with relics of gigantic Dinosaurians, some of the latter attaining lengths of more than one hundred and thirty feet. As to the more recent deposits of the Argentine Republic and Patagonia—partly Eocene and partly Pliocene—they are so rich in mammals that more than two hundred species, some of them of the most extraordinary types, have already been described by Dr. F. Ameghino,* Burmeister, and Moreno; and every number of the Revista Argentina brings some new descriptions of new fossils both from the Argentine and Patagonia, which is now explored by Carl Ameghino. There are among them ungulates which, to use Mr. Lydekker's words, are "totally unlike any found in all the rest of the world put together," † and which combine the characters of both the odd-toed and the even-toed ungulates. Of them, the *Macrauchenia* seems to be a direct descendant of a type which must have been a common ancestor to both divisions. Another huge mammal, one of the *Toxodontes,* which must have equaled in size the hippopotamus, also occupied an intermediate position between the two groups; while in the earlier Tertiaries there are types which, so far as can be judged from

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* His chief works are: Los mamíferos fósiles de la America del Sud, Buenos Ayres, 1880; Contribución al conocimiento de los mamíferos fósiles de la República Argentina, 2 parts, forming vol. vi of Actas de la Academia de Ciencias de Córdoba, Buenos Ayres, 1889; and several papers in Revista Argentina de Historia Natural, Buenos Ayres, 1891.

† Nature, vol. xlv, p. 608.

preliminary descriptions, must have stood near the source from which both ungulates and rodents have taken their origin.

Very many interesting Edentata and rodents have been met with in the same beds, but it is the marsupial group which surpasses all others in interest. One carnivorous animal of this group (*Prothylacinus*) is almost identical with the now existing pouched wolf (*Thylacine*) of Tasmania; while another fossil genus (*Protoproviverra*) is quite akin to the most characteristic carnivorous marsupial, the Tasmanian Devil. Although F. Ameghino's descriptions are not yet complete, the best authorities on this subject in this country and Germany do not hesitate to recognize a purely Australian type in these South American forms, which, on the other side, can safely be connected with the group of primitive carnivors (*Hyænodon, Pterodon,* etc.) which appeared at a later epoch in Europe. Moreover, the same beds contain fossil remains of primates (*Homunculus, Anthropops, Homocentrus, Eudiastatus*) which seem to represent ancestors of all the subsequent apes, but stand also in connection with the lemurs, and also with the ungulates, or, rather, with their *Toxodon* ancestors. They seem to represent the most ancient primates known, and indicate that the first representatives of the whole group must be sought for as far back as the end of the Secondary period. Finally, we must mention the discovery of remains of man which are considered by F. Ameghino as belonging to the Pliocene and Miocene ages.*

The "missing links" are coming, as we see, in such abundance that it will take several years before anatomists, in whose hands this rich material will now be put, have disentangled the numerous and striking affinities between so many different types which we have briefly enumerated. But geologists will also have a word to say about these discoveries, which raise again the very great question as to the long-since noticed affinities between the faunas of all southern continents and the presumed previous connection between those continents. Apart from all other considerations, the resemblance between the fossil marsupials of South America and the marsupials now living in Australia is so great that it is not possible to admit that forms so near to each other (and both so abnormal) might have developed independently upon two remote continents. It seems almost unavoidable to admit that some direct land connection has existed between South America and Australia, although all we know about the

* The Revista Argentina contains in its issue for December last a full description of the primates discovered by Carl Ameghino in south Patagonia. The connections which these fossils indicate between man, primates, ungulates, and rodents are of the highest interest.

persistence of the chief outlines of the continents seems to be opposed to the admission. Dr. Ihering, who has devoted a good deal of time to the study of the fauna of South America, boldly concludes from his own special researches that during the Secondary period a great continent extended from Chili and Patagonia, through New Zealand, to Australia, while the connection between South America and North America was broken during both the Cretaceous period and a great part of the Tertiary epoch. The striking differences between the faunas of both Americas, and the identity of many representatives of the faunas of South America and South Africa, make him also conclude that the two latter continents were connected as late as the Oligocene period.* R. Lydekker, whose opinion has such a weight in the matter, also concludes from the many known affinities between the fossil faunas and floras of the four great southern prolongations of the continental mass of the globe that they must have stood in a more or less intimate connection, and have been partially isolated from the more northern lands.† As to F. Ameghino, he also recognizes that, at least during the Oligocene times, South America was in direct connection with the Old World; but he points out the similarity of the mammalian and Dinosaurian faunas of both Americas, and concludes that the two continents must have been connected, as well as North America with Europe, at an earlier epoch.

It would be premature to attempt now the solution of this complicated question. It may be permitted, however, to point out that the hypothesis of a submerged antarctic continent is not improbable from the point of view of the physical geographer. The permanence of the continents, which is a fact, and seems to be opposed to the hypothesis, must be understood in a limited sense. In the equatorial and the two temperate zones we undoubtedly have huge continental masses, the great plateaus of Asia, both Americas, and Africa, which, so far as our knowledge goes, have not been submerged since the primary epoch; and around these backbones of the continents we have huge masses of land which have not been under the sea since the end of the Secondary period. But their outskirts have witnessed several retreats and invasions of the ocean, or of its Secondary period seas. Moreover, the permanence of the continents does not seem to extend to the circumpolar zones. When we consider the outlines of the two great plateaus of East Asia and North America, we see that these two great continents of the Secondary epoch

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* Revista Argentina de Ciencia Natural, No. 4 (Sobre la distribución geográfica de los Creodontes, and letter to F. Ameghino).

† Nature, 1892, vol. xlvi, p. 12.

were narrowing at that time toward the north, and that their extremities were pointing toward some spot in the vicinity of what is now the Bering Strait, in the same way as South America, South Africa, and South Australia are now pointing toward the south pole. The great plateau of northeast Asia, which has remained a continent ever since the Devonian age, has so much the shape of South America pointing northeast that the resemblance is simply striking.* On the other side, we know that the Miocene flora discovered in Greenland, Spitzbergen, and New Siberia indicates the existence of a great Miocene continent where we now have but the ice-clad arctic archipelagos. So that we must conclude that, while the central (temperate and equatorial) parts of the globe really offer a certain permanence in the disposition and general outlines of their continents, the arctic region stands in a different position. It was under the ocean during a large part of the Secondary period, it emerged from the ocean and was occupied by a large continental mass during the Tertiary period; and now it is again under water. Such being the conditions of the arctic region, we may suppose that the same oscillations took place in the antarctic region as well. In such case, the two circumpolar regions would have been periodically invaded by the ocean (either alternately or during geological epochs closely following each other), and they would have periodically emerged from the sea in the shape of continents more or less indented by gulfs and channels. In short, a certain stability in the distribution of land and water in the equatorial and temperate zones, and unstability in the circumpolar regions (with, most probably, an unstable Mediterranean belt), would perhaps better express the observed facts than a simple affirmation of stability of continents. If these considerations prove to be correct—and I venture to express them only as a suggestion for ulterior discussion—then the hypothesis of a former more or less close land-connection between the southern extremities of our present continents would not appear unlikely, and the striking similarity between the faunas of Patagonia and Australia would be easily accounted for.

III.

Few branches of science have developed with the same rapidity as bacteriology during the last few years. The idea that infectious diseases are due to some micro-organisms invading the body of the infected animal is certainly old. It was ventilated many

* Petermann's and Habenicht's map of Asia, in Stieler's Hand Atlas (No. 58), shows this shape of the plateau better than any other map. For more details see my map in the Orography of East Siberia, in the Memoirs of the Russian Geographical Society, 1875, vol. v (Russian).

hundreds of years ago; and it was revived early in our century. But scientific bacteriology is of quite recent creation. It dates from the end of the fifties—that is, from Pasteur's researches into the fermentation of beer and wine and Virchow's investigations into cellular pathology. Progress has been very rapid since. We have now numerous works, large and small, devoted entirely to the description and study of the life-history of the microscopic organisms which occasion disease; and every year brings the discovery of some new micro-organism to which some disease, or group of diseases, may be attributed. Cholera, typhoid fever, gastric affections altogether, malaria, and influenza; tuberculosis, leprosy, and cancer; diphtheria, measles, and scarlet fever; rheumatism, anthrax, small-pox, rabies, and tetanus; nay, even the poison of the cobra snake,* have been traced to separate microscopical beings. The photograph of each separate bacillus or micrococcus may be found in the text-books; its manners of life, and very often its modes of reproduction, have been carefully studied, both in the animal body and in artificial cultures; so also its morbid effects when introduced into the bodies of various animals. True that the general reader is often amazed on learning that such and such a microbe which was introduced a few months ago, as the real cause of influenza or of some other disease, is recognized now as a common inhabitant of the human body, and has nothing to do with the said disease; while a few months later the real enemy will again be discovered, but will have no more success than its predecessor. But such ephemeral discoveries are simply indicative of an unhappily general tendency among modern scientists—that of hastening to announce discoveries, and to attach one's name to something new, before the supposed discovery has been submitted to the test of searching experiment. The same tendency prevails in all sciences—the only difference being, that the general reader is seldom gratified by the daily press with the discovery of a new chemical "law," or of a new "type" of fossil mammals, while each discovery which deals with disease, ephemeral or not, enjoys a wide publicity so soon as it has found its way into a scientific periodical. The very rapidity with which the would-be discoveries of new bacilli are reduced to their real value only proves, on the contrary, the safety of the methods used by bacteriology for distinguishing between the seeming and the real causes of disease.

We may thus safely recognize that science already knows a great number of micro-organisms which are capable, under certain circumstances, of producing certain specific diseases; and we

* M. Calmette, in Archives de médecine navale et coloniale, mars, 1892; referred to in Revue Scientifique, 23 avril, 1892.

may note that even those researches which, at the first sight, seem to overthrow established facts, only result in a deeper knowledge of diseases and their modifications. Thus, the recent investigations of MM. Lesage and Macaigne, who have finally succeeded in differentiating the typhoidic bacillus from the *Bacterium coli*—a microbe which is constantly met with in our intestines, and only under certain conditions acquires an especial virulence—are one of the best examples of how further research deepens our knowledge of microbes; and Dr. Cunningham's discovery of ten different varieties of the choleraic bacillus* certainly will have the same effect: it will simply widen our knowledge of the different forms assumed by cholera.

Things stand, however, quite differently with the means of combating infectious micro-organisms. Most of the specifics which once awakened so many hopes have proved in the long run to be as ineffective against bacilli as the specifics periodically proposed by allopaths and homœopaths are powerless against the diseases themselves. And the more the study of bacteria is advancing, the more it is recognized that a healthy body which is capable of itself putting a check on the development of morbid micro-organisms is the best means of combating them; that sanitary measures which prevent the very appearance of morbid germs are the surest means against the possibilities and the risks of infection. But what permits a healthy body to resist its invasion by morbid organisms? What gives several animals immunity against certain special diseases? Why do rats resist anthrax, and dogs and monkeys resist the tuberculosis of fowls, while the same microbes are fatal to rabbits and guinea-pigs? And how can immunity against certain diseases be acquired either by vaccination or by previously having suffered the same disease? We know the microbes; but what is it that renders them highly offensive in some cases, and quite inoffensive in some others?

Several theories have been constructed to explain the phenomena of immunity; and, although none of them has succeeded in dispelling all doubts, it must be recognized that each of them accounts for at least large groups of phenomena. In fact, of the two leading theories, one being purely biological, while the other pays its chief attention to the chemical aspects of the subject, they rather complement than contradict each other. The broadest and most ingenious of all explanations of immunity is the theory, elaborated in 1883 by Elie Metchnikoff, which represents an extension of the leading principles of struggle for life to the

* Scientific Memoirs by the Medical Officers of the Army of India, Part VI; analyzed in Annales de Micrographie, 1892.

microscopic constituents of the animal body.* Besides the cells which constitute the animal tissues, there are in the body of man and all vertebrates a number of free cells—the white corpuscles of blood and lymph and the wandering cells of the tissues—which exhibit all the characters of real amœbæ. Four different varieties of these amœboid cells, usually known under the general name of *leucocytes*, have been described—the distinctions between them being chiefly based upon the shape and the numbers of their nuclei; but the commonest form is that of a speck of protoplasm containing several nuclei which are connected by filaments of nuclear substance, as well as a little radiated sphere which plays such an important part in the bipartition of cells.†

The leucocytes of both the higher and the lowest animals have all the distinctive features of simple amœbæ. They protrude pseudopodia, and move about like amœbæ (only the smaller ones, usually described as lymphocytes, possessing this capacity to a smaller extent), and, like amœbæ, they are endowed to a high degree with the capacity of ingesting all kinds of small granules which they find in their way, such as grains of coloring matter suspended in water, and various smaller micro-organisms. It is very easy to observe how leucocytes of the frog, the pigeon, the guinea-pig, and so on, ingest bacilli by surrounding them with their protoplasm; and an immense literature, with illustrations by photographs and correct drawings, has already been published in order to show how various bacteria and micrococci are ingested by leucocytes. In some cases the thus ingested bacilli are *digested* —that is, transformed into a soluble matter which is assimilated by the protoplasm of the leucocyte, exactly in the same way as an amœba digests a diatom. In other cases the bacteria are for some time kept alive within the leucocytes, and if the leucocytes have been put into conditions which are unfavorable for themselves but favorable for bacteria, the latter develop, and are set free. It has also been seen pretty often that some bacilli propagate, by means of spores, within the leucocytes, or that the spores which have been kept for some time seemingly without life, begin to develop and give origin to a new generation of bacilli.‡

* See his paper Immunity, in British Medical Journal, January 31, 1891. Also his last most attractive and profusely illustrated work, Leçons sur la Pathologie comparée de l'Inflammation, Paris, 1892, which can be safely recommended to the general reader, notwithstanding its rather technical title. Its subject is the struggle for life carried on within organisms by the amœboid cells against the microbes.

† See Recent Science in the Nineteenth Century, May, 1892, p. 758. The best morphological description of leucocytes is to be found in Ehrlich's Farbenanalytische Untersuchungen zur Histologie und Klinik des Blutes, Berlin, 1891, quoted by Metchnikoff.

‡ P. Netschajeff, Ueber die Bedeutung der Leucocyten bei Infection der Organismen, in Archiv für pathologische Anatomie, 1891, Bd. cxxv, p. 415.

These are facts, perfectly well proved, and confirmed by numberless observations made upon both the leucocytes of higher vertebrates and the amœboid cells of lower organisms. In fact, the whole first part of Metchnikoff's Leçons sur l'Inflammation is given to the description of like observations upon the ingestion and digestion of bacteria and other micro-organisms, and these observations are so conclusive that we already see growing a new science—comparative pathology—which will have to study the diseases and the means of defense against disease in all classes of animals. More than that. Not only those leucocytes which happen to be near to a microbe introduced within the body, do swallow it. It is now certain that as soon as microbes, or even some foreign substance like a splinter or coloring matter, is introduced into the body, the wandering white corpuscles of the body immediately move toward the foreign matter or organism, as if they were endowed with a certain irritability or sensibility, which directs their movements. This fact is so usual that Metchnikoff is even brought to advocate the idea that the distinctive feature of every inflammation is such a gathering of leucocytes around the infected spot, in order to destroy, if possible, the cause of infection. The defense of the living body by means of its phagocytes would thus be a fundamental character of all organisms, high and low, acquired and perfected during their evolution under the necessities of struggle for life.

However, not all bacteria are ingested by leucocytes. Thus, the leucocytes of mice (which so easily succumb to anthrax) do *not* swallow the anthrax bacilli; and those of pigeons and rabbits (who succumb to chicken-cholera) do not swallow the bacilli of that special disease. This fact has, however, nothing very astonishing in it, as it has its analogy in the life of the lowest organisms. Thus it has been proved that the plasmodium of the slime-fungi, or *Mycetozoa* (it occurs as a gelatinous mass on the surface of trees), which consists of numberless nucleated amœbulæ, and creeps by itself over the bark of the trees, most distinctly displays a certain option in choosing the direction of its movements. If cauterized at some spot of the part which moves foremost, it changes the direction of its motion, and leaves the cauterized spot behind. A decoction of dead leaves attracts it, while a solution of sugar or salt repels it.* The same is known of isolated amœbæ. So also the leucocytes immediately attack and ingest some microbes, living or dead, but avoid some others, and various kinds of leucocytes behave in various ways. The mono-nuclear leucocytes of man seem loath to attack the bacilli of erysipelas, while the many-nuclear ones display no such re-

* Metchnikoff's Leçons sur l'Inflammation, pp. 38 *et seq.*

luctance. Altogether, some substances exercise upon leucocytes a decidedly attractive power, while other substances repulse them.

As to what happens with microbes which have been ingested by leucocytes, the result may be very different in various conditions. The red corpuscles of blood, when ingested by leucocytes, are digested; globules of pus and fragments of muscular tissue also are digested by means of a special ferment (discovered in 1890 by Rosbach). And the same happens with microbes if the leucocytes of the organism are healthy and the animal is refractory to a given disease, either from natural causes or in consequence of vaccination. The bacilli of anthrax are undoubtedly destroyed by the leucocytes of the dog, as well as by those of such rabbits as have been vaccinated against anthrax. If the leucocytes are healthy, they prevent the germination of the spores which they have ingested; but they maintain this power so long only as they are healthy; because, if the animal has been submitted to cold (or to heat in the case of a frog), or if it has been narcotized,* it loses its immunity. Moreover, the very affluence of phagocytes to an infected place may be accelerated through nervous action, or slackened by various narcotics.

Such being the facts, it was quite natural to explain them, as Metchnikoff did, by maintaining that the phagocytes are the natural means of defense of organisms against infectious disease. The very necessities of struggle for life have evolved this capacity of the organisms of protecting themselves by sending armies of phagocytes to the spots attacked by noxious micro-organisms. The struggle may evidently end in either the defeat of the phagocytes, in which case disease follows, or the defeat of the microbes, which is followed by recovery; or, the result may be an intermediate state of no decisive victory on each side, as is the case in various chronic diseases. †

As to the force which attracts the leucocytes toward the microbes, it is already indicated by the extensive researches of the other school, which has devoted its chief attention to the chemical aspects of infection. It may be, as it is maintained by Mas-

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* E. Klein and C. F. Coxwell in Centralblatt für Bacteriologie und Parasitenkunde, 1892, Bd. xi, p. 464.

† Besides the powers of ingesting and destroying noxious granules, the leucocytes also contribute to the defense of the body by forming capsules around the granules, as well as by carrying them out of the organism through the skin. Transpiration is a familiar instance of the latter case. Mr. Herbert E. Dunham's observations on the Wandering Cells of Echinoderms and the Excretory Processes in Marine Polyzoa (Quarterly Journal of Microscopical Science, December, 1891), and Brunner's researches on transpiration (Berliner klinische Wochenschrift, January 23, 1892), are especially worthy of note under this heading.

sart, Bordet, and Gabrichevsky, that the leucocytes are attracted by the chemical poisons secreted by the micro-organisms; or the protein of the bacterial cells themselves may bring them on the spot, as is maintained by Buchner, who also has conclusive experiments in favor of his theory. Only further research will be able to decide which of these views is correct, and to what extent. But under the present state of knowledge the question can not be answered with certainty—the more so as Behring, Kitasato, Buchner, Emmerich, Vaillard, Tizzani, Cattani, Ch. Richet, and many others have weighty arguments in favor of the opinion that the immunity of animals depends upon some ferment-like albuminous substance contained in the serum of their blood. Strenuous efforts have been made of late by Koch, Buchner, E. H. Hankin,* and many others to come to some more definite knowledge of these "defensive proteins," which are known in science under the names of "alexines," "sozins," "phylaxins," and so on. But it will probably take some time before our notions about these substances take a definite form. One thing seems, however, to become more and more certain—namely, that the serum of the blood of immune or vaccinated animals, although in many cases it does not destroy the microbes themselves, is nevertheless possessed of a vaccinating power. This fact is settled beyond doubt; it is continually confirmed by fresh experiments; and it is recognized by the followers of the biological theory as well. As to its explanation, it may be sought for in the direction indicated by Metchnikoff—namely, that the serum, though not destroying the microbes themselves, destroys the poisonous substances which they are developing in the organism. In such case, organisms would be endowed with two means of defense instead of one; the two theories would naturally complete each other; and, may be, in some not very distant future they would enable man to combat with success some of the worst microscopic enemies of the human race.—*Nineteenth Century.*

A curious illustration of the indirect influence of the environment on human character is given in Mr. Greswell's Geography of South Africa, where it is observed that the indigenous woods of the country do not seem especially adapted for boat and ship building. The dearth of good ship-timber must partly account for the complete degeneracy of the Dutch colonists at the Cape as a seafaring people. With no good harbors at hand, with no navigable rivers, and no ship-timber for spars or masts, the change in their character and traditions as a maritime and fishing folk to a nomadic, pastoral, and continental people, might almost have been conjectured from the beginning. At the present time the up-country Boer has extremely vague ideas of the ocean and of all things.

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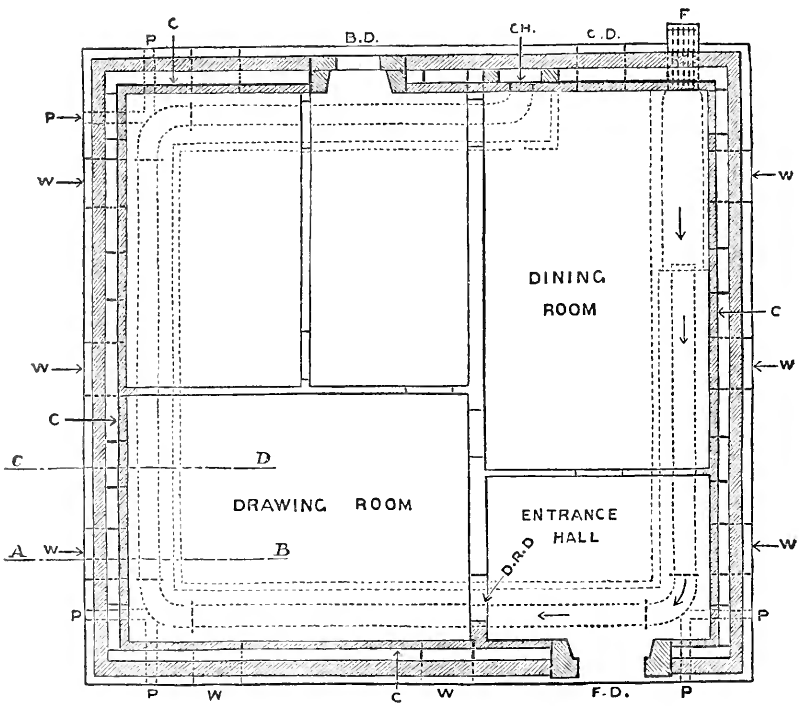
* See the reports of the last Hygienic Congress held in London, in September, 1891.

WARMING AND VENTILATING OF DWELLINGS.

THE best practical application of the principle of warm walls and cold air is undoubtedly the house which M. Somesco, civil engineer, has built for himself at Creil. We were fortunate in visiting M. Somesco on a day when a strong northeasterly gale was blowing. Wind creates greater difficulties than cold; but on this occasion we had both wind and cold. It is important to note that M. Somesco's house is built on marsh land. On both sides of the house there is a river, and but for the construction of embankments flood would constantly occur in this spot. It was necessary to dig six feet below the level of the cellar floor to find a foundation. As much masonry had to be placed under the house to form a foundation as would have sufficed to build it. The garden, in the midst of which the house stands, was also artificial. Nor is there any shelter from the winds. The house stands alone in the midst of what is now a garden, but which used to be a dismal swamp. The system of warming and of ventilation has therefore been tested under the most trying circumstances. In shape M. Somesco's house is square, measuring twelve metres. It has cellars, two floors, and above these under the roof a large sort of hall which serves as a billiard-room. The hollowed walls are fifty-five centimetres thick. The external wall is twenty-two centimetres and the inner wall eleven centimetres, so that there is an intervening space between the walls of twenty to twenty-two centimetres. These walls are made with porous bricks, but in the basement the walls are massive. The house is like one box inside another box, with a space of four to five inches between the two boxes.

Outside, at the back of the house, there is an ordinary coal-furnace. The smoke and heat from this furnace pass into a chamber built in the cellar of the house, measuring about six feet in length and not quite two feet square. From this heat-chamber and going all round the outer walls of the cellar there is an inclosed passage. Suspended in the center of this passage and also going the whole way round the house is a metallic flue of more than a foot in diameter (thirty-five centimetres internal and thirty-seven centimetres external diameter). This serves as a chimney and draws off the smoke and the heat from the furnace and heat-chamber, traveling horizontally round the four sides of the house; and then, when it is nearly back to the furnace, the flue opens into a chimney; the smoke and what heat remains go up vertically to the roof. In other words, the basement of the house is surrounded by a narrow closed passage, in the center of which is suspended the flue or chimney from the furnace, and this flue serves to warm the air in this passage. To keep the cellar cool and to retain the heat that goes round the cellar, the wall of this passage is covered over with "sluck wool" or "silicate cotton," as it is sometimes called, which is considered a better non-conductor than asbestos. All round the house communicating with this hot-air passage there are inlets of fresh air from the garden, which measure eighty by fifty centimetres and are protected by metallic gauze or webbing. If the wind is very violent, a coarse canvas may be hung in front of these air inlets on the windward side of the house. There are ten such inlets, the fresh air being delivered, as will be seen in the sectional drawing A B, below the hot-air flue. The pipe or flue rests on iron bars and on a socket that permits the easy dilatation and

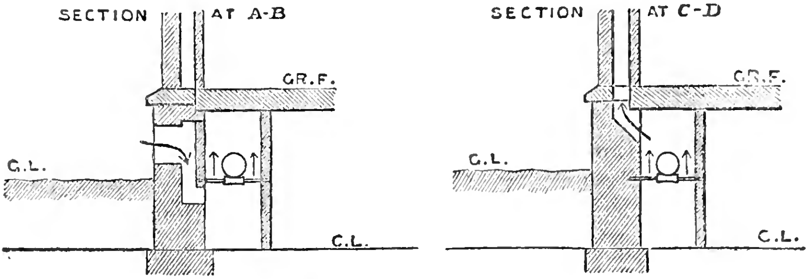
PLATE No. 1.



PLAN OF GROUND-FLOOR OF M. SOMESCO'S HOUSE AT CREIL, OISE, FRANCE.

The dotted lines indicate the warming flue passing down the center of the hot-air passage in the basement of the house. The plan gives the walls underneath the windows and indicates the space for hot air between the outer and inner wall. C C C, the arrows show the hot-air space between the walls. C D, the door from the garden into the basement. B D, the back door. F D, the front door. D R D, the door from the entrance hall to the drawing-room. F, the furnace lit in the garden outside the house. The arrows from the furnace indicate how the smoke and hot air pass horizontally round the house till they reach C H, where a chimney carries the smoke vertically up to the roof. P P P P, apertures through which brushes may be passed from the garden into the smoke-flue to clean away the soot. W W W W, position of the windows.

PLATE No. 2.



PLAN OF BASEMENT OF M. SOMESCO'S HOUSE AT CREIL, OISE, FRANCE.

Section A–B, showing inlet of air into the basement passage where the air is warmed. G L, the ground level of the garden. C L, the ground level of the basement or cellar. GR. F., the parlor floor, or first floor of the house. The inlet of air as indicated by the arrows is below the smoke-flue, which is suspended in the center of the passage, so as to warm the air in this passage.—Section C–D. G. R. shows the outlet of the air above the smoke-flue. The air warmed by contact with this flue passes upward in the intervening space between the inner and outer walls of the house, so as to warm the entire substance of the walls.

contraction of the iron with which it is made. The drawing C D shows how the air warmed in this passage ascends into the space between the two walls of the house. There are a number of these openings into the hollow of the wall all round the house.

The temperature in the hot-air passage varies from 114° to 122° Fahr. This suffices to bring up the temperature of the inner wall on the ground-floor from 86° to 92° Fahr. The temperature of the inner wall decreases by about one degree centigrade per metre of height. Thus, if the wall on the ground-floor level is at 35°, it will be 32° C. on the level of the first floor, which is three metres higher up. The hot air that travels up the hollow of the walls comes out in the large attic under the roof of the house. If this air is warmed to from 114° to 122° Fahr. when it enters the space between the walls it will have fallen to about 104° Fahr. as it emerges from the wall into the attic. From this attic the hot air filters into the open through the porosity of the roof and by the various openings, chinks, etc.

Much of the success of this experiment depends upon the porosity of the walls. Every precaution is taken not to interfere with this porosity. There is no plaster-work put on the walls, and there is no paint or paper. A light wooden frame is nailed on to the walls, and from this tapestry—that is, a tissue, as far as possible a woolen tissue—is suspended and replaces paper. Some hangings of this description can be obtained that are hardly any dearer than good paper, and though for artistic purposes expensive woolens are employed, the expense in the long run is not great, for the cloth lasts an indefinite time, and, unlike paper, can be taken down and cleaned. It also contributes very materially to maintain the warmth of the walls. M. Somesco has now lived in this house for some years. Without the aid of fires, when the windows were shut, he has never known the temperature of the rooms fall below 54° Fahr., and this during the hardest frost. If the windows were thrown wide open the temperature indoors would not fall below 39° Fahr. in spite of the frost. The air coming through the windows is absolutely cold and frosty, but the thermometer rises under the influence of the heat radiated from the walls. There is a fireplace in each room, though fires are very rarely lighted. When, however, it is very cold weather and the windows have been open for a long time, then it is expedient to light a fire for an hour or so. As there is no loss of heat through the coldness of the walls, the room is warmed in a very short time. On the day of our visit the drawing-room windows had been open for two hours, and as the weather was very cold a fire was lighted, but soon the fire was let out, the room was too warm, the thermometer marking 78° Fahr. We left the drawing-room for some time. We opened the front door leading to the garden, and the drawing-room door, which was from four to five feet from the front door. Thus the fresh air from the garden blew freely into the drawing-room. Yet, and though there was now no fire, the radiation of heat from the walls was such that the thermometer marked 66° Fahr. In the garden the temperature was below 50° Fahr., and a strong northeasterly gale was blowing. Thus we were while indoors breathing cold, pure air from the garden.

We have seen that M. Somesco's house was built on a swamp; and yet the principal, if not the only, inconvenience from which he has suffered is extreme dryness. We visited other houses in the neighborhood and found the walls stained by the damp to a height of six or seven feet; some of M. Somesco's furniture and other objects were spoiled because the wood had split in consequence of its extreme dryness. To counteract this inconvenience, M. Somesco has been obliged to place a large number of plants in different parts of the house, a measure which, however, adds considerably to the charm and beauty of the place.

The heat and dryness thus secured cost M. Somesco ten tons of English household coals per annum. His house has fourteen rooms, and ten persons could live comfortably in it. The cost would then be one ton of coal per head per annum. But then it must be noticed that the furnace and the system of warming the passage round the basement of the house are somewhat roughly contrived, and that more economical methods of obtaining the necessary heat could be easily devised. Then it must also be noted that it is not a question of warming one room or a portion of a room, but that the entire house is equally warmed, and warmed to such an extent that doors and windows are constantly opened, and this in spite of the exceptionally cold and damp nature of the surrounding soil and the exposed position the house occupies.

Over and above all these considerations M. Somesco maintains he has realized the ideal that a dwelling should be like our clothes, only not portable, but permeable. It should be warm, because it should be made of materials that are bad conductors of heat. Indoors we should possess means of counteracting the chilling effect of the outer air. We ought to live indoors as we live out of doors, and we should consider our house merely as if it were an extra great-coat. The coat, if porous, will be warm and healthy. One of the reasons, he says, why we are apt to feel uncomfortable when it rains is that the rain blocks up the porosity of the walls, and that, too, on the windward side. As for microbes, M. Somesco proudly pointed to the artistic drapery which covered the bare bricks of his porous walls. "These are," he exclaimed, "my microbe traps. If I have any reason to believe that injurious microbes have been introduced into my house, I know pretty well where to find them. It would take but little time or trouble to unhook all this drapery, to put it into the disinfecting stove, and there superheated steam under pressure, without injuring the cloth, would assuredly kill the microbes. Even without these artificial methods of purification, if the walls were porous, oxygen would go wherever the microbe went, and Nature would effect its own cure." How far a porous wall can filter and purify air, as earth filters and purifies sewage, is a matter which has not yet been investigated. He is of opinion that if we leave our walls alone, and do not block them up with paint and paper, we have for ordinary house walls in ordinary weather two cubic feet of air going through every square foot of wall in the course of an hour, and this is probably enough to insure the sufficient oxidation, if it goes on at all, of the materials of which the wall is made. Further, the porosity of the walls must also materially assist in the ventilation of the room which they surround. It was M. Somesco's delight to think that even when the doors and windows of his house were shut the pure air of his garden was blown upon him through the porous walls.

M. Somesco's house can, of course, only be taken as an experiment. The principles of which it is a practical application have not yet been adopted by the public. Already a private house is in the course of construction at Beauvais built on the same principles, and they are also to be applied to the military hospital at Madrid. To sum up these new theories and methods, the teachings of M. Trélat, the practical experiments of M. Somesco, suggest that the natural porosity of our walls, especially the outer walls, should not be destroyed. These walls should be decorated, not with paper and paint, but with porous, non-conducting substances, such as woolen drapery. The outer walls on the side nearest to the inner surface should be hollowed throughout, thus constituting a double wall, with a space of about four inches between the two walls. A heating contrivance of whatever description may be found most expedient or economical should be placed in the basement of the house. A warm-air chamber or shaft traveling round the base of the outer walls should supply to the hollow in the walls air taken from the outside and warmed at the point of admission into the wall to a temperature of from 100° to 120° Fahr. This should maintain the temperature of the inner wall at from 80° to 90° Fahr. Then, he considers, the walls will radiate sufficient heat through the rooms to enable the inhabitants to constantly open the doors and windows, and to breathe cold, fresh, outer air without inconvenience. As a rule, fires will be unnecessary, dampness will be completely banished from the house, and to maintain some moisture in the air it would, he thinks, be expedient to decorate the house with numerous evergreen plants. The inhabitants should then be able to benefit by unlimited ventilation, and could breathe pure, cold, and fresh air coming upon them directly from the outside.—*Report of the London Lancet Sanitary Commission.*

The address of T. Baldwin Spence, President of the Biological Section of the Australian Association, dealt with the fresh-water and terrestrial fauna of Tasmania, and the introduction of the present animals of Australia and the way their descendants had become distributed. The struthious birds—the ostriches, emus, cassowaries, and kiwis—were, with the exception of the African ostrich, which ranged into Arabia, confined to the southern hemisphere, while they were supposed to have originated in the northern hemisphere and migrated southward. But by this hypothesis there were great difficulties in explaining how the struthious birds reached Australia and New Zealand without being accompanied by placental mammals. Also, the struthious birds of New Zealand, including the lately extinct moas, were smaller, and made a nearer approach to the flying birds, from which the struthious birds were descended, than did any of the others, and they should expect to find the least altered forms near the place of origin. The tinamus of Central and South America, although flying birds, resembled the New Zealand struthious birds in several particulars; and as a former connection between New Zealand and South America was shown by the plants, the frogs, and the land shells, it seemed more probable that the struthious birds of Australasia originated in the neighborhood of New Zealand from flying birds related to the tinamus, and that they spread thence into Australia and New Guinea, rather than that they should have migrated southward from Asia. Probably the ostriches of Africa and South America have a different line of descent from the struthious birds of Australasia, and might have originated from swimming birds in the northern hemisphere.

SKETCH OF ALEXANDER WINCHELL.

WHILE he was industrious and versatile as an original investigator, Prof. Alexander Winchell was best known as a successful, instructive, and entertaining lecturer on subjects of science, especially of geology and evolution, and as the author of numerous books which have found their way into the households of our country, describing in a style interesting and comprehensible to all the latest results of research and of his own labors in those fields.

ALEXANDER WINCHELL was born in Northeast, Dutchess County, N. Y., December 31, 1824, and died in Ann Arbor, Mich., February 19, 1891. His family were in moderately comfortable circumstances. His father and mother had been teachers in the public schools of the town. He showed a taste for mathematics at an early age, which was illustrated by his having completed the first part of Emerson's arithmetic and his reciting the entire multiplication table without mistake on the day he was seven years old. When a little more than ten years old he had completed Willett's arithmetic, and had transcribed all the definitions, rules, problems, and full solutions in a manuscript book. He attended the Stockbridge Academy and the village school. It had been intended that he should study medicine, but on his expressing, when sixteen years old, a desire to teach, his father engaged a district school in which he taught during the winter of 1840 and 1841. As by-pursuits he collected and solved arithmetical problems, and began the practices, which he never discontinued, of recording the results of his reading and study, and keeping a diary and a strict account of expenditures. He continued his mathematical studies, soon acquired an enlarged idea of the preparation needed to fit him to become a doctor, became more attached to the profession of teacher, and had "his imagination fired" by the study of astronomy. In 1843 he became assistant in Amenia Seminary, where he had attended for a year as a student. Having entered Wesleyan University in 1844 as a sophomore, "he encountered with indignation," says his editorial biographer in the American Geologist, "the first check in his educational ardor and success in a rigorous 'marking system,' which at that time laid special stress on the literal reproduction of the words of the text-books." Though ambitious for honors, he refused to compete for them under those conditions. Having been graduated in 1847, he was appointed teacher of natural science in Pennington Male Seminary, New Jersey, "when he entered with irrepressible zeal and delight upon the study of the flora of the vicinity. The Morse telegraph having just come into operation, he attempted with success, and with no special knowledge beyond the fundamental principles, the production of a working instrument, which he exhibited at a public lecture.

His ambition was now extending beyond mathematics. Declining offers of a tutorship in that science in Wesleyan University and of continued position in Pennington Seminary, he accepted the chair of Natural Science in Amenia Seminary. Here he gave his first public geological lectures; explored the flora of the vicinity, of which he contributed a catalogue to the regents of the university; observed solar spots; and began a series of meteorological observations.

He removed in 1850 to take charge of an academy at Newbern, Ala. Finding the prospects of the institution not equal to his expectations, he undertook to revive a suspended institution at Eutaw in the same county. Here he began a course of scientific investigations which he had been indefinitely projecting for some time. He communicated to the American Journal of Science notes on the cold of January at Eutaw, and on the aurora borealis of September 29, 1851; opened a correspondence with the Smithsonian Institution, to which he sent collections of plants, alcoholic specimens, and preserved skins, including the new species of fish, *Hybopsis Winchelli;* and communicated to the American Association in 1853 the first scientific description of the Cretaceous Choctaw Bluff, on the Black Warrior River. In 1853 Prof. Winchell became President of the Masonic University, Selma, Ala., and made a tour of the southern part of the State, to interest the people in the institution. The tour was also a geological one, and took him through a country rich in Cretaceous and Tertiary fossils, where Hippurites encumbered the ground and were burned into lime, and the "precious vertebræ" of Zeuglodon were used for andirons, stiles, and gate-weights. He sent a collection of fishes to the Smithsonian Institution, in acknowledging which Prof. Baird predicted that in not many years he would be called to a big professorship somewhere North or East. "Nine days after these words were penned," says his biographer in the American Geologist, "he was elected to a chair in the University of Michigan." This was in 1853; the professorship was that of Physics and Civil Engineering. He found on taking his chair, in January, 1854, that no good elementary text-books on civil engineering were in existence, and that he had to originate matter and methods. As a branch of physics he attended to the keeping of a complete series of meteorological observations, which, while he held the chair, he reported to the Smithsonian Institution. In the next year he was transferred, in accordance with an understanding that was had when he first went to the university, to the newly created chair of Geology, Zoölogy, and Botany. In a paper

On the Importance of the Study of Natural History, read before the State Teachers' Association in 1856, he advocated the introduction of that subject into the Union schools and the lower classes of the colleges. In the fall of 1857 he opened a class in comparative osteology. A geological survey of the State of Michigan having been ordered, he was commissioned as its director, and began, in 1859, with one assistant, the examination of the southern part of the lower peninsula. He fixed the position of the salt waters of East Saginaw to within two feet of their actual level, and in his report, published in August, 1861, fully anticipated the vast development of the salt interest in the Saginaw Valley. The official survey was suspended by the breaking out of the civil war, but the paleontological investigations were carried on privately. Prof. Winchell pointed out the gypsum bed near Tawas, which had been pronounced barren, but has proved marvelously rich; studied the "Marshall group" and its relations with the Chemung; investigated the cherry slug and currant worm; published numerous geological papers and an address on the soils and subsoils of Michigan, in which he insisted on the agricultural value of the pine lands; studied the oil-producing regions of the United States and Canada; and published a report on the Grand Traverse region, and a paper on the fruit-bearing belt of Michigan, in which attention was first called to the influence of Lake Michigan in ameliorating the climate of the State and prolonging the growing period. The Geological Survey of Michigan was reorganized in 1869, and Prof. Winchell was again appointed its director. He had learned much during the interval since the survey was suspended, as our enumeration shows, in his private travels for economical surveys, of the rock structure and physical features of the State. In 1871 he had prepared a preliminary report; but hostile political and personal influences had been working against him, and the appropriation for printing the report failed to pass the Legislature. He resigned his position, and the report, embodying the results of two seasons of field work in the lower peninsula, largely remains unpublished. A part of the material intended for it was condensed for Walling's Atlas of Michigan, and these memoirs were afterward collected in a volume, accompanied by topographical, geological, and isothermal charts.

In 1873 Prof. Winchell was called to the position of Chancellor of Syracuse University. He held it only for about one year, when the anticipated financial resources of the institution having shrunken considerably in the actuality, and he having been asked to take part in public efforts to augment the endowment, he resigned it. He had been told that the authorities of the institution had been attracted to him by his scientific reputation, and that they wished him not to discontinue his pursuits in that line. He had, however, already found the presidency interfering with his scientific work, and the additional burden was too much. "For the duties of solicitor of money," says his biographer, "he had no qualification. Between paleontologist and financial agent was a gap so broad that he had never contemplated crossing it." He, however, in December, 1874, accepted the chair of Geology in the same university. For this department he prepared an extended syllabus of a proposed course of geological lectures, which should possess interest for the general public, but found it difficult in the financial condition of the institution to equip and maintain laboratories corresponding with his ideas of the professorship of Geology. While occupied with this problem, he was invited to become Professor of Geology, Zoölogy, and Botany, in Vanderbilt University, Nashville, Tenn. He accepted an engagement for three months, without severing his connection with Syracuse University, for he opened there a School of Geology, in January, 1876, which he wished to make a permanent feature of the institution; but the enterprise was not fully successful till 1878. He divided his time between Syracuse and Vanderbilt Universities. He found the authorities of the latter institution attached to the old ideas, and in no way disposed to give ear to the new theories of evolution. He nevertheless began his course under what might be considered favorable auspices. In 1877 he published a theory of a relation of meteorites to the disturbances of the satellites of Mars, and several papers in strictly orthodox books and newspapers, unfolding his theory of Preadamites, or of the existence of races of men before Adam; which, he held, was not contrary to divine revelation, but was authorized by a proper construction of the Scriptures. His views were kindly received, even when they were not believed, in the North, but were very unwelcome to his Southern friends. At the commencement season of Vanderbilt University of 1878, Prof. Winchell was warned that his "heterodox" position in reference to Preadamites and evolution was having an influence adverse to the interests of the university, and was asked to decline a reappointment to his professorship. He refused to do this on such grounds as were alleged. On the same evening he delivered one of the addresses of the commencement occasion; and on the next morning the Board of Trust of the university abolished his chair. It had been intended to have the thing quietly done, but Prof. Winchell published all the facts, and was not the one who suffered in reputation from the transaction. Of this incident, Dr. Andrew D. White says, in his New Chapters in the Warfare of Science: "That his lectures at the Vanderbilt University were learned, attractive, and stimulating, even his enemies were forced to admit; but he was soon found to believe that there had been men earlier than the period of Adam, and even that all the human race are not descended from Adam. His effort in this was to reconcile science and Scripture, and he was now treated by a Methodist Episcopal bishop in Tennessee just as, two centuries before, La Peyrère had been treated for a similar offense by a Roman Catholic vicar-general in Belgium. The publication of a series of articles on the subject, contributed by the professor to a Northern religious newspaper at its own request, brought matters to a climax, for, the articles having fallen under the notice of the leading South-western organ of the denomination controlling the Vanderbilt University, the result was a most bitter denunciation of Prof. Winchell and of his views. Shortly afterward the professor was told by Bishop McTyeire that 'our people believe that such views are contrary to the plan of redemption,' and was requested by the bishop to quietly resign his chair. To this the professor made the fitting reply: 'If the Board of Trustees have the manliness to dismiss me for cause, and declare the cause, I prefer that they should do it; no power on earth could persuade me to decline.' 'We do not propose,' said the bishop, with gratuitous suggestiveness, 'to treat you as the Inquisition treated Galileo.' 'But what you propose is the same thing,' rejoined Dr. Winchell. 'It is ecclesiastical proscription for an opinion which must be settled by scientific evidence.' Twenty-four hours later Dr. Winchell was informed that his chair had been abolished, and its duties, with its salary, added to those of a colleague; the public were given to understand that the reasons were purely economic; the banished scholar was heaped with official compliments, evidently in hope that he would keep silence. Such was not Dr. Winchell's view. In a frank letter to the leading journal of the university town, he stated the whole matter. The intolerance-hating press of the country, religious and secular, did not hold its peace. In vain the authorities of the university waited for the storm to blow over. It was evident, at last, that a defense must be made, and a local organ of the sect, which, under the editorship of a fellow-professor, had always treated Dr. Winchell's views with the luminous inaccuracy which usually characterizes a professor's ideas of a rival's teachings, assumed the task. In the articles which followed, the usual scientific hypotheses as to the creation were declared to be 'absurd,' 'vague and unintelligible,' 'preposterous and gratuitous.'" While in Nashville Prof. Winchell constructed some pieces of microscopic apparatus and a small working steam-engine of one fifth horse-power, and completed a survey of the sanitary geology of that city.

In June, 1879, Prof. Winchell was unanimously recalled by the Board of Regents of the University of Michigan—a body that was by no means united on most questions—to the professorship of Geology and Paleontology in that institution. He went back under much more favorable conditions for scientific advancement than had existed when he left the institution seven years before. "His duties at that time were spread over the whole field of geology, zoölogy, botany, museum and microscopical work. When he returned, the faculty embraced a Professor of Geology and Paleontology; a Professor of Mineralogy and Economic Geology; a Professor of Zoölogy; an Assistant Professor of Botany; an Instructor in the Microscopical Laboratory; and a Curator of the Museum—all of whose duties devolved upon one man in 1872." He began on his return to the university the preparation of an extended syllabus of a course of instruction in general geology, accompanied by copious references to sources of information. He presided over the Section of Anthropology at the Montreal meeting of the American Association. He spent the summer of 1886 in connection with the Geological Survey of Minnesota in field work in the extreme northern part of the State, north of Lake Superior. His work extended into twenty-four townships, where he noted and studied the outcrops at eight hundred and ninety localities, and he spent much time in the succeeding winter in the study for his first Minnesota report of the Archæan problems thus developed. The observations made in this survey were important, and were found to throw much light on some of the problems of Archæan geology. The plan of the next year's survey extended over the original Huronian area, and also over the iron regions of Michigan and Wisconsin and into the area of the Animikie in northern Minnesota. He entered into the study and discussion of practical questions touching the stratigraphic relations of the older terrenes and accumulated a large mass of data, the discussion of which he was never able to complete. He planned for a thorough discussion and examination of the data of the Archæan rocks, including their field relations and petrographic characters, and for the sake of it declined all but the most important invitations to lecture. In pursuance of this work he communicated to the eighteenth report of the Minnesota Survey (1889) a review of American opinion on the Presilurian rocks, and presented further results of his work in northern Minnesota at the Toronto meeting of the American Association. His last year (1890) was one of his busiest, and was occupied with lectures, attendance on scientific meetings, geological excursions, and the preparation of plans for enlarging the laboratory of the university. Prof. Winchell was a leading spirit in the formation of the Geological Society of America and in the establishment of the American Geologist.

His biographer in the American Geologist believes that Dr.

Winchell was perhaps the very first man of science in America "who descended before popular audiences from that high-caste and stately but dry and unpopular style in which the older scientists had thought it fit to cloak the dignity of science. . . . He simplified zoölogical themes rather than popularized them, and lifted up his voice only . . . where the select appreciators of science were numerous enough to constitute an audience." Societies for scientific culture, summer institutes, and similar organizations, formed a large part of the audiences.

Prof. Winchell was a voluminous writer. The list of his books and papers in the American Geologist includes two hundred and fifty-five titles. A predominant idea running through his Christian Theology illustrated from Nature was that of the harmony between the indications and doctrines of science and the central doctrines of the Christian religion. A similar thought ran through several other of his works. His Geology of the Stars and his World Life were attempts to extend the history of the earth as recorded in the geological strata so as to include the whole lifetime of a world, or to present, as he said in the preface, "a thoughtful review of the processes of world formation, world growth, and world decadence." Many of the thoughts in these works were so novel that he was not able to get an expression of opinion upon them from his fellow-students. A large proportion of his books are scientific treatises for popular reading—vivacious, suggestive, embodying the accurate results of scientific investigation, sparkling with original thoughts, and well adapted to their purpose.

The burden of his educational labor, according to his biographer, lay in the direction of widening the avenues of natural science and of its introduction into secondary schools. "He insisted that the young student is more observing than reflective or analytic, that the education of the mind should be by an appeal to its most accessible and most powerful impulses, and that the influence of science on the human mind, especially in its formative stage, is more healthful to a normal growth, more conducive to moral rectitude, and more stimulating toward a right ambition, than any other field of knowledge. . . . He believed that there is as much mental and ethical culture to be derived from the study of natural science, when pursued with equal thoroughness and exactness, as from the study of Greek or Latin literature or of mathematics."

EDITOR'S TABLE.

THE CLAIMS OF SCIENCE.

IN the present day, when so many schemes for the reformation of society are on foot, and so many experiments are being made in the treatment of social diseases, it is of the very first importance that the claims of science to an authoritative voice in human affairs should be faithfully and adequately presented. The efforts which such writers as Spencer and Huxley have made in this direction are known to all well-informed persons, but there is still room for the enforcement of the lesson, and we welcome the appearance of a new and vigorous champion of the good cause in Prof. Karl Pearson, author of the Grammar of Science, recently published in the Contemporary Science Series. There are many points touched upon in Prof. Pearson's book which might give rise to difference of opinion; but no one who is imbued with the true scientific spirit can fail to concur most heartily in what he says in his opening chapter as to the "claims of science."

The first claim of science is founded on the essential difference between scientific and unscientific opinion. "The classification of facts," says Prof. Pearson, "and the formation of absolute judgments upon the basis of this classification—judgments independent of the idiosyncrasies of the individual mind—is peculiarly the scope and method of modern science. The scientific man has above all things to aim at self-elimination in his judgments, to provide an argument which is as true for each individual mind as for his own. . . . The scientific method of examining facts is not peculiar to one class of phenomena and to one class of workers; it is applicable to social as well as to physical problems, and we must carefully guard ourselves against supposing that the scientific frame of mind is the peculiarity of the professional scientist." Not only is this method not that of the average man, but its very existence is scarcely surmised by him. His method—if such it can be called—of arriving at conclusions is to fasten his attention on a few salient facts, and to interpret them according to his own prepossessions and interests. If asked to take a point of view from which, perhaps, other facts would become salient, or to divest himself of self-interest as a canon of interpretation, he will in general decline; in many cases, indeed, he will be totally incapable of responding to the invitation. The idea of requiring a wide range of facts as a basis for induction, of checking the result of a first survey or examination by that of a second, third, fourth, or tenth, and of treating self-interest or previously formed opinion as a disturbing influence from which the judgment is to be kept as free as possible, is one which long ages of struggle with the problems of Nature have at length bequeathed to the scientific workers of to-day, but which has no lodgment, and but slight recognition, in the minds of the multitude. Prof. Pearson is, however, of opinion that an instruction in scientific method might be very generally imparted, and that its effect on the mind of the ensuing generation would be marked. He considers, very rightly, that a scientific frame of mind is an essential of good citizenship, seeing that it is that frame of mind alone which leads a man to look beyond proximate phenomena, and above all to put aside personal bias. It is the peculiarity, as he well observes, of scientific method that, when once it has become a habit of mind, that mind converts *all* facts whatsoever into science. Good intentions are not enough to make a good citizen; a man may with the best of intentions, and even at great self-sacrifice, set himself in direct opposition to the best interests of the state. The trouble in such a case is that the man lacks knowledge, and, like an ignorant physician, either diagnosticates badly the evils he would remedy, or, if his diagnoses chance to be right—which is very unlikely—applies the wrong cure. Prof. Pearson does not pretend that as yet science can pronounce definitive and certain judgments upon all social questions; but he properly maintains that science should, as far as possible, be our guide to-day, and that it alone will ever lead us into a perfect comprehension of our social duties. We are, therefore, in full accord with him when he formulates what he calls the first claim of science in the following words:

"*Modern science, as training the mind to an exact and impartial analysis of facts, is an education especially fitted to promote sound citizenship.*"

The first claim of science being that it supplies the requisite *method* for dealing with social questions; the second, which flows naturally from the first, is that it brings actual principles to light which afford the most important guidance in social matters. Such Prof. Pearson holds to be Weismann's discovery—if it be one—of the non-inheritance of characteristics acquired during the lifetime of a parent organism. If Weismann's theory be correct, then, in Prof. Pearson's words, "no degenerate and feeble stock will ever be converted into healthy and sound stock by the accumulated effects of education, good laws, and sanitary surroundings. Such means may render the individual members of the stock passable, if not strong, members of society; but the same process will have to be gone through again and again with their offspring, and this in ever-widening circles, if the stock, owing to the conditions in which society has placed it, is able to increase in numbers. . . . If," our author significantly adds, "society is to shape its own future, we must be extremely cautious that, in following our strong social instincts, we do not at the same time weaken society by rendering the propagation of bad stock more and more easy." The argument under this head is not affected by the truth or falsity of Weismann's theory. If Weismann is right, we have to shape our conduct in such a way as to make the propagation of bad stock as difficult as possible, and we shall depend for the future welfare of society mainly upon a careful selection of stocks; if he is wrong, and stocks, no less than individuals, can be improved by education and outward circumstances, we shall apply ourselves more energetically to work in these directions. In either case, a verdict which science alone can render, is of the first importance in determining social action.

The third claim which Prof. Pearson makes for science is the obvious one that its suggestive discoveries afford means for the improvement of all the material conditions of human life. In the popular apprehension this is the one incontrovertible claim of science, and upon this point, therefore, it is not necessary to lay much stress. It may, however, be remarked that many of the greatest practical triumphs of science in the present age have flowed from discoveries or observations which at the outset it was hard to link, even in imagination, with any important practical result. In the words of our author, "The frog's legs of Galvani and the Atlantic cable seem wide enough apart, but the former was the starting-point of the series of investigations which ended in the latter." In like manner, it is suggested, the recent discovery of Hertz, that the action of electro-magnetism is propagated in waves like light, and that light, as conjectured by Maxwell, is only a special phase of electro-magnetic action, may in a generation or two do more to revolutionize life than even the discovery of Galvani as developed in the electric telegraph.

In the fourth place, science, instead of repressing, as some erroneously believe, tends to develop the imagination. Our author puts the case well: "All great scientists have, in a certain sense, been great artists; the man with no imagination may collect facts, but he can not make great discoveries. If I were compelled to name the Englishmen who during our generation have had the widest imaginations and exercised them most beneficially, I think I should put the novelists and poets on one side, and say Michael Faraday and Charles Darwin." When facts have been accumulated and classified and their relations have been carefully traced, the next step is the discovery of some comprehensive formula which, conceived as a law or principle in nature, will sum up and explain the totality of the phenomena. This, as Prof. Pearson states, "is the work not of the mere cataloguer but of the man endowed with creative imagination."

Finally, science not only stimulates but disciplines the imagination and, with it, the æsthetic faculty. "With the growth of scientific knowledge," it is well remarked, "the basis of the æsthetic judgment is changing and must change. Many things in poetry and art which pleased our grandfathers, or even our fathers, are becoming to us, from our changed point of view, insipid and foolish. Many expressions that were part of the recognized stock in trade of poetry are losing, if they have not already lost, all their value for æsthetic purposes. It is not that our generation is growing less susceptible to beauty, but that it can not recognize as beauty that which is not felt to repose on the true." In the conclusion of his introductory chapter Prof. Pearson states that science endeavors to provide a mental *résumé* of the universe; and, though this great synthesis is not complete, and probably never will be, "it is better to be content with the fraction of a right solution than to beguile ourselves with the whole of a wrong solution"—words which we heartily echo. We do not think there is a point in this truly valuable chapter—the introduction to what is on the whole a most valuable book—on which we have not ourselves insisted at one time or another; but, as stated above, we rejoice at the appearance in the field of every new prophet of scientific truth. Prof. Pearson is not a new writer entirely, but in this work he appeals to a new circle of readers, to many of whom we have no doubt he will bring home a new and salutary conception of the place and function of science in the modern world. The battle of science seems to be nearly won, but overconfidence is always dangerous, and, as our author himself remarks, we see in our time "the highest intellectual power accompanied by the strangest recrudescence of superstition." Let the guardians and champions of truth be, therefore, unremitting in their vigilance and ceaseless in their efforts, till science has become to all mankind the symbol of blessing and of hope.

THE ROCHESTER MEETING OF THE AMERICAN ASSOCIATION.

Under the dignified and tactful presidency of Prof. Joseph Le Conte, of the University of California, the American Association for the Advancement of Science held a pleasant and profitable meeting at Rochester, August 17th to 23d. The University of Rochester placed its commodious buildings at the disposal of the Association; within a few paces stood open the doors of the Ward Natural Science Establishment; the nurseries, for which the city is famous, were of easy access; and in its Silurian outcroppings and glacial drift the vicinity had much to attract the geologist. In his address as retiring president, Prof. A. B. Prescott, of the University of

Michigan, showed how inseparable are pure and applied science in the field of chemistry, making a forcible plea for the endowment of original research. No laboratory work worth doing, he argued, can ignore laboratory work already done; study of the latest books, memoirs, and periodicals must go hand in hand with experiment. Nature is best known face to face, but the printed page is usually essential for the introduction.

In Section A, that of Mathematics and Astronomy, Prof. J. R. Eastman, of Washington, as vice-president, delivered an address on Neglected Fields in Fundamental Astronomy—in determining the absolute position of the stars. Interest in this section centered in the spectroheliographs taken and exhibited by Mr. George E. Hale, of the Kenwood Astrophysical Observatory, Chicago. These pictures mark a notable advance in the application of photography to astronomical research, the solar faculæ for the first time being clearly seized. In acquiring information regarding the earth, Mr. R. S. Woodward described how he had been able to approach accuracy within one part in five millions: in measuring the base-lines for the United States Coast and Geodetic Survey he had secured constancy of length in a standard bar by immersing it in melting ice.

In Section B, that of Physics, Prof. B. F. Thomas, of Columbus, Ohio, chose for the subject of his address as vice-president, Technical Education in Colleges and Universities. He held that their mathematical courses of education are usually too elaborate, are rarely drawn as they should be from practical examples, and ought as much as possible to be adapted to the special career the student means to enter upon. He noted with gratification how Stevens Institute was doing one thing well, and would rejoice to see other technical institutes each devoting itself to thorough education in civil, mining, and other distinct departments of engineering or other science. He commended literary studies and the art of clear and ready speaking. It is not so much what a man knows, he said, as the proportion of it that he can communicate, that makes him useful. Papers of value in this section discussed the sensitiveness of photographic plates, the photographic analysis of vowel-sounds, and a photographic mapping of the magnetic field. Interesting ascertainments of the distribution of energy in the spectra of the glow-lamp and the arc-light were also presented.

In C, the Chemical Section, the vice-president, Prof. Alfred Springer, of Cincinnati, spoke upon Micro-organisms of the Soil, indicating the important part they play in the chemistry of vegetation. Prof. H. C. Bolton, of New York, stated that his bibliography of chemistry, comprising ten thousand titles, is in press. Mr. Alfred Tuckerman, also of New York, read a brief note on a list of mineral waters, with analyses, which he is preparing for publication.

In Section D, that of Mechanical Science and Engineering, Prof. J. B. Johnson, of St. Louis, delivered an address on The Applied Scientist. Much attention in this section was bestowed upon instruments of precision and the difficulties attending their manufacture. Prof. W. A. Rogers, of Waterville, Me., had found the lack of homogeneity in even the highest grades of steel to be a grievous obstacle. Mr. J. A. Brashear, of Allegheny, Pa., stated that he had found a fortnight's labor necessary in bringing a plate two inches square to a satisfactory surface as a plane.

In E, the Geological Section, Prof. H. S. Williams, of Yale, the vice-president, gave a masterly address on The Scope of Paleontology and its Value to Geology. Prof. R. T. Hill, of Washington, read a paper on The Volcanic Craters of the United States, of much interest.

In Section F, Biology, Prof. S. H. Gage, of Cornell University, set forth The Comparative Physiology of Respiration, in his address as vice-president. Respiration, he said, is a mere mechanical help to enable oxygen to permeate living substance. Oxidation is not direct in the living tissue, as in a burning candle, but the tissue takes the oxygen and makes it an integral part of itself as it does carbon and other elements, and when finally energy is freed the oxidation occurs and carbon dioxide appears as a waste product. An animated debate in this section turned upon Weissmann's criticisms of the Darwinian theory that characteristics acquired during the individual life are transmitted to offspring. Prof. Manly Miles cited Dr. Dallinger's experiments in support of Darwin's view. These experiments, conducted continuously for seven years, had gradually brought micro-organisms, extremely rapid in their rate of reproduction, to enduring a temperature of 158° Fahr.; their normal temperature having been 60°. Prof. C. V. Riley remarked that most insects are born orphans; if they do not inherit characteristics acquired through the experience of their ancestors, how can they come into the world so richly endowed in aptitude and instinct, and what can so clearly difference the instinct of one insect from that of another? In this section the pressure of papers has of late years been so excessive that it was decided to divide the section in two: what in future will be known as Section F will take zoölogy for its field, and Section G (G being hitherto an unappropriated letter) will be devoted to botany. It is proposed that during each annual meeting a day shall be set apart for joint sessions, when papers occupying ground common to zoölogy and botany will be read and discussed.

In H, the Anthropological Section, Mr. W. H. Holmes, as vice-president, delivered an address on The Evolution of Æsthetics. Prof. F. W. Putnam outlined the archæological and ethnological exhibits to be presented under his direction at Chicago next year. He has a staff of some seventy explorers at work gathering anthropometrical statistics and collecting material. His reproductions of Indian settlements will represent aboriginal life in North, Central, and South America. The Canadian Government, through Prof. William Saunders, of Ottawa, will extend important co-operation; the New York State Commissioners for the World's Fair will provide an Iroquois stockaded village, with its characteristic long house of bark.

In the absence of Mr. S. Dana Horton, Section I, that of Economics and Statistics, chose Prof. Lester F. Ward as its vice-president. His thoughtful and provocative address treated The Psychological Basis of Social Economics. Economists, he said, have laid undue stress on the biological forces, the strictly individualistic aims, to be observed in human society. As intelligence and sympathy increase, the effect is that purely animal impulses are not simply qualified, but often reversed; competition steadily gives place to an ordered co-operation which, in the end, is much more gainful to all concerned than the first estate of universal conflict. The question as to what is best to be done with the municipal services which are in their nature monopolies, received some elucidation at the hands of Prof. E. W. Bemis, of the University of Chicago. He brought down to date his studies of municipal gas-works, maintaining that they had yielded substantial benefits as contrasted with works in corporate hands. Danville and Alexandria, Va., and Wheeling, W. Va., he said, operate their electric lighting as well as their gas supply municipally; and more than one hundred towns and cities in the United States own and manage electric-lighting plants.

The Entomological Club, which met concurrently with the A. A. A. S., heard an interesting paper from Mr. L. O. Howard, of Washington, detailing his plan of campaign against the mosquito. He employs kerosene spread as a thin film over the breeding-places of the insect; the oil remains efficacious for two weeks, and, as a little of it goes a long way, the cost is a mere trifle.

A capital lecture, fully illustrated, on Hypnotism, was given to the Rochester public by Prof. Joseph Jastrow, of the University of Wisconsin. Mr. C. K. Gilbert, of Washington, who discoursed on Coon Butte and Theories of its Origin, did not prove so interesting. It is perhaps in its endeavor in some measure to requite hospitality by its public lectures that the management of the Association is most open to criticism. Had popular elements in the Rochester programme received more attention, it is safe to say that the local accessions would have exceeded the small total of twenty-six.

Madison, Wis., was chosen for the next place of meeting, with Prof. William Harkness as president. The vice-presidents elected were: Section A, Mathematics and Astronomy, Prof. C. L. Doolittle, South Bethlehem, Pa.; B, Physics, Prof. E. L. Nichols, Ithaca, N. Y.; C, Chemistry, Prof. Edward Hart, Easton, Pa.; D, Mechanical Science and Engineering, Prof. S. W. Robinson, Columbus, O.; E, Geology and Geography, Prof. C. D. Walcott, Washington; F, Zoölogy, Prof. H. F. Osborn, New York; G, Botany, Prof. C. E. Bessey, Lincoln, Neb.; H, Anthropology, Prof. J. Owen Dorsey, Tacoma, Md.; I, Economic Science, Prof. William H. Brewer, New Haven, Conn. The probable time of the next meeting will be the week beginning August 19, 1893.

The Geological Society of America accepted an invitation to hold its winter meeting at Ottawa, Canada, December 28th–31st.

LITERARY NOTICES.

Essays upon some Controverted Questions. By Thomas Henry Huxley, F. R. S. New York: D. Appleton & Co. 1892. Pp. 489. $2.

Most of these essays were first printed from time to time in the Nineteenth Century, and afterward republished here in the Monthly. They were written, the author says, without premeditated purpose or intentional connection in reply to attacks upon doctrines which he holds to be well founded; or in refutation of allegations respecting matters lying within the province of natural knowledge which he believes to be erroneous. The circumstances of their origin gave them a polemical tone, the traces of which disappeared from his heart after the heat of controversy was over, but which he has allowed to remain as being most just on the whole to all, and especially as excusing the occasional severities his antagonists may have indulged in. The author's main thought in the papers has been to show that the events of the world and of life have been and are the outcome of a regular sequence according to fixed laws, and that the intervention of a supernaturalism on which much stress is laid by the "other side" is superfluous—not necessary, and not proved; not that he denies the existence of a supernaturalism, or of real powers and knowledge, equivalent to those which the supernaturalists predicate; for, "looking at the matter from the most rigidly scientific point of view, the assumption that amid the myriads of worlds scattered through endless space there can be no intelligence as much greater than man's as his is greater than a black beetle's; no being endowed with powers of influencing the course of Nature as much greater than his as his is greater than a snail's, seems to me not merely baseless, but impertinent. Without stepping beyond the analogy of that which is known, it is easy to people the cosmos with entities, in ascending scale, until we reach something practically indistinguishable from omnipotence, omnipresence, and omniscience. If our intelligence can in some matters surely reproduce the past of thousands of years ago, and anticipate the future thousands of years hence, it is clearly within the limits of possibility that some greater intellect, even of the same order, may be able to mirror the whole past and the whole future; if the universe is peopled by a medium of such a nature that a magnetic needle on the earth answers to a commotion in the sun, an omnipresent agent is also conceivable; if our insignificant knowledge gives us some influence over events, practical omniscience may confer indefinably greater power." Thus the principle of scientific naturalism of this age "leads not to the denial of the existence of any supernature, but simply to the denial of the validity of the evidence adduced in favor of this or of that extant form of supernaturalism." The author here employs the words "supernature" and "supernaturalism" in their popular sense, but to him the term "Nature" covers the totality of what is. The world of psychical phenomena appears to him as much a part of Nature as the world of physical phenomena; and he is unable to perceive any reason for cutting the world into two halves, one natural and one supernatural. As all of the world's classics have been put to the test of scientific criticism and dissection, Prof. Huxley sees no reason why the Bible should escape the same treatment; and these essays, as our readers may recollect, discuss certain features of the biblical narrative from the point of view of scientific and experimental criticism. The author lays down a body of "established truths," which he specifies, to something like which theological speculations will have to accommodate themselves. These "truths" are irreconcilable with the biblical cosmogony, anthropology, and theodicy, but they are no less inconsistent with Voltairism and kindred systems. But Prof. Huxley is no enemy of the Bible. It appears to him that "if there is anybody more objectionable than the orthodox bibliolater it is the heterodox Philistine, who can discover in a literature which, in some respects has no superior, nothing but a subject for scoffing and an occasion for the display of his conceited ignorance of the debt he owes to former generations." Twenty-two years ago he pleaded for the use of the Bible as an instrument of popular education, but laid stress upon the necessity of placing the instruction in lay hands. He finds the further merit in the Bible that both Testaments "have been the great instigators of revolt against the worst forms of clerical and political despotism." While not believing that the highest biblical ideal is exclusive of others or needs no supplement, he does believe that "the human race is not yet, possibly may never be, in a position to dispense with it."

Christian Anthropology. By Rev. John Thein. With an Introduction by Prof. Charles G. Herbermann, Ph. D., LL. D. New York, Cincinnati, Chicago: Benziger Brothers. Pp. 576.

The author of this work is pastor of St. Martin's Roman Catholic Church, Liverpool, Ohio. Prof. Herbermann sets forth in his introduction that "the Church has taught for ages that between the truths of revelation and the truths of science there can be no conflict. The Vatican Council has solemnly repeated this teaching. On the other hand, some men famed for scientific learning and some famed for unscientific bluster proclaim that between faith and science no reconciliation is possible. Educated Catholics may well ask, How are such assertions possible? Still, it is not hard to find the explanation. If we could ascertain at once what are the truths of science and what are the truths of revelation, their comparison would end the controversy. But what are the truths of science?" Inquiring, the professor finds not the truths, but scientific opinion of what they are, vacillating and not wholly agreed. On the other hand, "we look to the Church to tell us what are revealed truths. . . . When the Church has spoken, we know what revealed truth is. But there are hundreds of opinions on dogma and morals which the Church has neither approved nor condemned, and thousands of biblical texts the meaning of which she has not defined." As it is not easy to find the truths of science or of revelation in every case, it is difficult to compare them with one another. When doctrines seem to be in conflict, it is well to inquire whether they have been established as truths by the Church on the one side or by science on the other; and it is not necessary to be troubled about conflict till this has been made to appear. Nevertheless, there are apparent conflicts, and "some scientific oracles" are doing their best with them to assail the dogmas of the Church. While the priests are informed only respecting one side, "difficulties, arguments on a new discovery, on scientific phenomena, against revealed truth, present themselves sooner or later to every priest in the exercise of his ministry"; and "the priest who knows only his dogmatic and moral theology may be surprised and confounded by objections formulated in entirely new language, supported by pretended fact or by a discovery wrongly interpreted." Father Thein, who is said to be an enthusiastic student of science, to have given years of study and research to anthropology, and to have read the literature of the subject exhaustively, has undertaken in this book to inform his brother clergymen, so that they may not have to go into the conflict unarmed. He reviews the whole system of modern anthropological science and of evolution, with clear knowledge of what has been written and much force of argument. When he finds a weak point, he exposes it unmercifully, and is not above occasional sarcasm. His treatise is intelligent, good-tempered, and readable. But, because, while he questions science everywhere, he accepts the established dogmas of the Church as fixed, his work is better adapted to satisfy those young priests who want to be supported in what they are determined to believe than those inquiring minds who refuse to admit that the dogmas are beyond investigation.

The Proceedings of the First Annual Meeting of the National Conference on University Extension. Compiled by George Francis James. Philadelphia: J. B. Lippincott Co. Pp. 292. Price, $1.50.

The spread of the idea of university extension has been rapid, whether the results it has worked out have all been mature or not. Within a year after the first center of extension teaching was established in Philadelphia in November, 1890, Mr. James informs us, more than two hundred such experiments were being carried on in nearly every State in the Union. The results of the first year's work showed the need of thoughtful conference and discussion on the part of those engaged in it. Accordingly, a National Conference on the subject was called under the auspices of the American Society for the Extension of University Teaching, and met in Philadelphia in the last days of 1891. It was attended by delegates from twenty States, representing some fifty of the best institutions of learning, and—either personally or by written report—every center of extension teaching which had so far been established in the country. The seventeen addresses and papers made and read at the meeting, and contained in this volume of the proceedings, regard the subject from as many different points of view. In addition to them, reports are given of the condition and prospects of university extension in the several States.

Matter, Ether, and Motion. By Prof. A. E. Dolbear. Boston: Lee & Shepard. 1892. Pp. 334.

Prof. Dolbear has essayed to give, in this little volume of three hundred odd pages, a brief account of the fundamental notions of modern physics, and to show the direction in which the thoughts of those are tending who are endeavoring to understand the ultimate mechanism of what we have been accustomed to call dead matter. The title of his volume clearly indicates the trend of such thought. To the physicist the hypothetical ether, which Grove in the forties contemptuously referred to as the clothes-horse upon which to hang the unknown, is becoming more and more a very definite reality. It is to him much more than a working hypothesis. He assumes its existence, and is busily occupied in trying to understand its ultimate structure—that is, how it must be constituted in order to explain the phenomena with which he has to deal.

He sees in it now not only a medium for the transmission of the wave-motions which manifest themselves as light, heat, and electricity, but is attempting to find in it the explanation of matter itself. The old conception of the atom as simply an ultimate particle, itself dead and inert, but endowed with forces by means of which it acts upon other particles, is giving place to a radically different one. This conception is that of the vortex ring. Any smoker can make one, and they are frequently thrown from the funnel of a locomotive in starting. Such a ring consists of a circle of material, all the parts of which are in rotation in the planes of the radii of the ring. Physicists have conceived that such rings formed in the ether—this being postulated as homogeneous and frictionless—might constitute the ultimate something which we term the atom. Such a ring in such a medium would be indestructible, it would be elastic, and the size of the ring and its rate of motion would constitute the differences which we recognize between the elementary substances, instead of these differences being due to the size and shape of ultimate hard particles and their impressed forces.

In this view matter itself becomes but a mode of motion, and the old conception of forces as entities disappears. Everything is in the last analysis reducible to motion in the ether, and whether any given set of motions manifest themselves as heat, light, or electricity depends upon the character of the motions. The ether is at once the medium for the transfer of all motion and the storehouse of all energy.

Prof. Dolbear has set forth these new views of modern physics briefly but clearly, and without calling upon the reader for more knowledge than that possessed by the average cultivated man. He does not present them as demonstrated science, but as the views which are gaining ground among scientific workers, and which hold out the promise of our ultimately understanding, in some greater measure than now, the ultimate structure of the physical universe.

Waterdale Researches; or, Fresh Light on the Dynamic Action and Ponderosity of Matter. By "Waterdale." London: Chapman & Hall, 1892. Pp. 293.

Since Newton first announced the law of gravity there have been innumerable attempts to formulate some working hypothesis of a mechanism by which the observed results might be produced. Newton himself repudiated the idea of the particles of matter acting upon each other through void space, and, though this conception of isolated particles endowed with attractive forces is commonly made use of in mathematical analysis, it has never been regarded by physicists as answering to any reality. They have recognized that the universe must be a plenum, and that gravity must in some way result from strains set up in a medium which fills all space. This view is now taking on more definite shape, and it is hoped that before a great while it may be possible to frame some intelligible and consistent theory of the operation of gravity.

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Ethan Allen, the Robin Hood of Vermont. By Henry Hall. New York: D. Appleton & Co. Pp. 207.

The purpose of the author of this work, who died, leaving it for his daughter to complete, was "to make a fuller life of Allen than has been written, and, singling him from that cluster of sturdy patriots in the New Hampshire Grants, to make plain the vivid personality of a Vermont hero to the younger generations." A picturesque hero he is made to appear. Had the records been less exact and romance been left to deal unrestrained with his career, he might in time have shone forth comparably with the most airy heroes of ancient myth and saga. He is compared with Robin Hood—that is, the Robin Hood of Ivanhoe—whose life was "an Anglo-Saxon protest against Norman despotism," as Allen's life was "a protest against domestic robbery and foreign tyranny." Although never a citizen of the United States, "he is one of the heroes of the State and the nation." While we find much about him to study profitably and admire, there are some features in his career that we can not unqualifiedly commend for imitation by our youth; neither can we censure him, for he acted according to his conscience, and consistently for a single end—the freedom of Vermont. He is best known for the capture of Fort Ticonderoga; but what he would have considered his most important service was the defense of the New Hampshire Grants. This part of the story reminds us much of some of the scenes of the territorial history of Kansas. There is the same mixture of lawlessness and submission to the law that the Free State men showed there. It was a singular position the New Hampshire grantees were in, of acknowledging the political sovereignty of New York, and opposing with violence its conveyance of the lands they claimed by another title. The story is well told, largely in the words of the original documents. Another most curious feature in Allen's career is revealed in his coquetting with the British for the recognition of Vermont's position, even at the expense of the United States. As it is shown in this book, his conduct appears to have been controlled by sound reason. Congress had not recognized Vermont, and had refused to admit it to the Union. What claim had the Government on the allegiance of Allen or other Vermonters who were thus denationalized, and forced, as it were, to look out for Vermont alone? Allen was ready to negotiate with Great Britain or any authority that would secure Vermont's independent position—and that was all there was of it. The story of Allen's capture at Montreal, his captivity and imprisonment, is graphically told, wholly in his own words.

The Stone, Bronze, and Iron Ages. A Popular Treatise on Early Archæology. By John Hunter Duvar. New York: Macmillan & Co. Pp. 285. Price, $1.25.

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Manual Instruction: Wood-work (the English Sloyd). By S. Barter. London: Whittaker & Co. New York: Macmillan & Co. Pp. 343. Price, $2.

In this work, after an exposition of general principles in the introduction, information and instruction are given in drawing, the varieties, qualities, etc., of timber and other materials, bench-work, and the arrangement and fittings of the workroom—furnishing, among other things, the items of a complete equipment for a class of twenty boys. The chapter on bench-work contains twenty-three exercises in mechanical operations of wood-working, and thirty models of articles that may be made. A preface is supplied by Mr. George Ricks, who defines manual training as "a special training of the senses of sight, touch, and muscular perception by thing which we term the atom. Such a ring in such a medium would be indestructible, it would be elastic, and the size of the ring and its rate of motion would constitute the differences which we recognize between the elementary substances, instead of these differences being due to the size and shape of ultimate hard particles and their impressed forces.

In this view matter itself becomes but a mode of motion, and the old conception of forces as entities disappears. Everything is in the last analysis reducible to motion in the ether, and whether any given set of motions manifest themselves as heat, light, or electricity depends upon the character of the motions. The ether is at once the medium for the transfer of all motion and the storehouse of all energy.

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Essays upon Heredity, and Kindred Biological Problems. By Dr. August Weismann. Edited by Edward B. Poulton and Arthur E. Shipley. Vol. II. The Clarendon Press, Oxford, 1892. Pp. 226. Price, $1.30.

This volume is made up from four essays upon the general subject of the title. In the first, Prof. Weismann describes the place and importance of retrogression in the development of animal life. The second essay deals with the musical sense in man and animals and its relation to natural selection. The third essay is controversial, and is an answer to certain criticisms of the views of Prof. Weismann on sundry biological questions. The last essay deals with the question of the reproduction of life, and is concerned with an attempt to understand the significance of the physical facts of the reproductive process. The work is addressed to students of biology, and requires acquaintance with the present state of biological inquiry to be read understandingly.

Contributions to North American Ethnology. Vol. II, in Two Parts. The Klamath Indians of Southwestern Oregon. By Albert Samuel Gatschet, and Vol. VI. The Cegiha Language. By James Owen Dorsey. Washington: Department of the Interior.

The monograph contained in the two large quarto parts of Volume II is a portion of the results of the Geographical and Geological Survey of the Rocky Mountain Region carried on under the direction of Major J. W. Powell. As described in Mr. Gatschet's letter of transmittal it deals with the beliefs, legends, and traditions of the Klamath Indians, their government and social life, their racial and somatic pecularities, and, more extensively, with their language. The group of Indians herein described comprises two chieftaincies, the Klamath Lake Indians and the Modoc Indians, the latter celebrated for their stubborn war with United States troops in 1872–'73. About a hundred pages in the first part of the monograph are devoted to an ethnographical sketch, the other seven hundred pages treating of the Klamath language and giving many Klamath texts. The whole of the second part is occupied with a dictionary having Klamath-English and English-Klamath divisions.

The language treated in Volume VI is the speech of the Omaha and Ponka tribes of Indians. Mr. Dorsey was a missionary to the latter tribe from 1871 to 1873, and resided with the Omahas from 1878 to 1880. The material of his monograph consists of myths, stories, and letters obtained from the Indians, with translations, both interlinear and consecutive. A dictionary and a grammar of the Cegiha language are in preparation.

Mathematical Recreations of Past and Present Times. By W. W. Rouse Ball. London and New York: Macmillan & Co. Pp. 241. Price, $2.25.

This is a book of curious interest, and, although the author confesses that the conclusions are of no practical use, and most of the results are not new, is not uninstructive. In the first of the two parts into which it is divided various problems and amusements of the kind usually termed mathematical recreations are described. In successive chapters are discussed questions connected with arithmetic, geometry, and mechanics; magic squares; and unicurval problems. In the second are discussed the three classical problems in geometry of the duplication of the cube, the trisection of an angle, and the quadrature of the circle, astrology, hypotheses as to the nature of space and mass, and the means of measuring time. Questions that involve advanced mathematics are excluded from both parts. Among the particular topics considered are the arts of coloring maps, of expressing conditions of physical geography by contour maps, games of position, the familiar "ferry-boat problems," geometrical puzzles, paradoxes on motion (sailing quicker than the wind, etc.), problems on force, inertia, work, stability of equilibrium, etc., perpetual motion, the boomerang, the puzzle of fifteen, the tower of Hanoi, Chinese rings, and the like; the knight's path on the chess-board, the art of traversing mazes, geometrical trees; the speculations on spaces of one, two, and four dimensions; and hypotheses concerning matter and gravity. Some of these problems are trivial; others are associated with the names of distinguished mathematicians; while several of the memoirs quoted have hitherto not been accessible to English readers.

The Atlantic Ferry: Its Ships, Men, and Working. By Arthur J. Maginnis. New York: Macmillan & Co. Pp. 304. Price, $2.

This is a book of general interest and considerable historical value. Many interesting articles on its subject have been published in various periodicals, but none that in themselves have covered the whole ground, and given, as the author says, an idea of the routine, forethought, and general arrangements necessary to carry on such a far-reaching organization as a great steamship line, and which would set forth the efforts of the men who have instituted and maintained such enterprises, and the nature and results of the more remarkable examples of vessels and machinery which they have employed. The effort has been made in this book to cover this ground; and the book gives the history, from the earliest institution of Atlantic steamers, of the several lines; chapters descriptive of the working, sailing experiences, and machinery of the Atlantic lines; notices of the men who have made and conduct the Atlantic ferry; sketches of eventful passages and scenes, etc.; facts concerning the manning, expenses, and cost of Atlantic lines; and Atlantic records and tables.

In the *Elementary Geography of the British Colonies*, published by Macmillan & Co. as one of their Geographical Series (price, 80 cents), the part relating to the British possessions in North America, the West Indies, and the southern part of the South Atlantic Ocean, is contributed by Dr. *George M. Dawson*, of the Geological Survey of Canada; and that concerning the colonies, dependencies, and protectorates in the northern part of the South Atlantic, Mediterranean Sea, Africa, Asia, Australasia, and Oceania is contributed by Mr. Alexander Sutherland, of Melbourne. India and Ceylon are not included, but are described in a separate volume of the Geographical Series. In both departments the descriptions are systematic, full, and satisfactory; and the geography is a valuable manual for whatever purpose such a work may be required.

In his book on *Electric Railway Engineering* (Rubier Publishing Company, Lynn, Mass.) the author, Mr. *Edward Trevert*, has endeavored to make the subject as plain and interesting as the present advance in the science will admit. The book is written wholly from an electrical point of view, and aims to make clear all the points connected with the management of electric railways. The power-house and its apparatus, generators, the construction of the line, motors, rheostats, electric heaters, trolleys, locomotives for heavy traction, trucks, car-wiring, and the storage-battery system are described and illustrated in the chapters severally assigned to them. Accounts are given of some illustrative roads, and remarks for motor men and station men; and some miscellaneous matters are treated of in the appendix. The author predicts a brilliant future for electric railroading.

We published a few months ago a paper by M. *Charles Henry* on *Odors and the Sense of Smell*, which included many facts and principles of great interest—some of them, doubtless, novel to most of our readers. Prof. Henry's full discussion of these subjects, with technical observations, tables, etc., which were not appropriate to a popular article, with descriptions of some special apparatus he has invented and applied, are given in a hand-book, *Les Odeurs; Démonstrations pratiques avec l'Olfactomètre et le Pèse-vapeur* (Odors; Practical Demonstrations with the Olfactometer and Vapor-Balance), which is published in Paris as a number of the Forney Municipal Professional Library of Art and Industry.

The *Etiology, Diagnosis, and Treatment of the Prevalent Epidemic of Quackery*—an address before the graduating class of a medical school—by Dr. *George M. Gould*, is devoted very largely to the denunciation of homœopathy. The offer of a prize of $100 is made for the best essay that shall, historically and actually, show up the ridiculous pretensions of modern homœopathic practice. Other medical "vagaries," like "Keeleyism," patent medicines, advertising, etc., are attacked with earnest vigor. Philadelphia.

A compendium of information is furnished by Dr. *P. C. Remondino*, concerning a region which is attracting much attention on account of its climatic advantages, in his book on *The Mediterranean Shores of America* (F. A. Davis & Co., Philadelphia, $1.25). The preparation of the book was suggested while the author was trying to unravel the intricate and contradictory information that is encountered in the study of climatology and its relation to the etiology of phthisis. Then he made a special study of his home climate, or rather climates, for he distinguishes seven kinds in southern California. The introduction is devoted to the discussion of generalities concerning the various features, several and collective, of climate, location, soil, altitude, exposure, sunshine, electrical conditions, etc., and is followed by descriptions of the several health resorts of the region and their peculiarities.

A book describing *The Chinese, their Present and Future; Medical, Political, and Social* (F. A. Davis, Philadelphia, $1.75), is by a Presbyterian medical missionary, Dr. *Robert Coltman, Jr.*, who became fascinated with the peoples of the far East, and particularly with those of China, by reading accounts of them in missionary journals and books. He was disappointed in his reading by a lack of detail and a meagerness of description, especially in regard to the social state of the people and country at present, and sought an opportunity to go and see for himself. Hence the book may be regarded as a labor of love. It gives a lively running account of what the author saw, experienced, and learned in northern China, throws many side-lights on the social conditions of the people of all classes, and adds chapters on the missionaries and their works, business opportunities, the present political situation of the country, and its future prospects.

The Hygienic Treatment of Consumption has been prepared by Dr. *M. L. Holbrook* to advocate the treatment of consumption by hygienic remedies, which are accessible to all who have the intelligence and the wisdom to acquire a knowledge of them and their application. It is methodical, and in the first part considers the nature and causes of the disease. Among the latter are the predisposing causes of various kinds, and the accidents which often result in consumption, and the micro-organisms as the immediate cause. The second and third parts discuss the prevention and treatment of consumption in its earlier stages and in more advanced cases. Most important of the remedies is enlargement of the chest and lungs, both as preventive and as curative measures in the early stages of the disease. They are secured through expansion by breathing, vocal culture, and a large number of physical exercises which are described. Food, clothing, the dwelling, horseback-riding, the will and will power, and many other physical agencies much neglected are discussed; also resting in the open air at various seasons and its advantages. The book is written mainly for the patient, who may select from the various remedies such as are more especially adapted to his needs. (M. L. Holbrook & Co., New York.)

Phases of Animal Life Past and Present (Longmans, $1.50) is the name of a collection of essays by R. Lydekker, which are intended to illustrate in a popular manner a few of the various modes in which animals—especially vertebrates—are adapted to similar conditions of existence; and also to demonstrate some of the more remarkable types of structure obtaining among the higher vertebrates. Special attention is given to the curious creatures of past geological ages, but living forms are not neglected. The animals described are classed as "mail-clad," "flying," "swimming," "primeval salamanders," "fish lizards" (short-necked), "plesiosaurs" (long-necked), "tortoises and turtles," "giant land reptiles" (dinosaurs), "flying dragons" (pterodactyles), "giant birds," "egg-laying mammals" (monotremes), "pouched animals" (marsupials), and "dogs and bears," followed by chapters on teeth and their variations, horns and antlers, and rudimentary structures. The style is clear and entertaining, the descriptions are specific, and the illustrations are excellent.

A book published by Putnams, on *Materialism and Modern Physiology of the Nervous System*, is the substance of an address that was delivered before the Philosophical

Faculty of Columbia College, by *William H. Thomson.* The author finds the expressions of modern physiologists on the connection between nerve and consciousness indefinite and unsatisfactory. He examines the development of the nervous system from the lowest vertebrates up to man, and discussing the questions at issue, concludes that there is that in consciousness and mental operations that can not be accounted for by nervous action alone, but something must be called in to assist; therefore matter, force, and consciousness are three distinct realities.

In *Architecture, Mysticism, and Myth* (Macmillan), a study is presented by *W. R. Lethaby* of the influence of Nature and men's ideas of the universe and of divinity on their art. The author distinguishes between the common use of the term architecture, which is rather applied to building, and the sense in which he employs it, as "the synthesis of the fine arts." "As the pigments are but the vehicle of painting, so is building but the vehicle of architecture, which is the thought behind form, embodied and realized for the purpose of its manifestation and transmission." The two are regarded as "quite clear and distinct as ideas—the soul and the body." Of these enumerated ultimate facts behind all architecture, which have given it form, the author studies particularly the influence of the known and imagined facts of the universe, the connection between the world as a structure and the building as a whole. His study brings him evidence "of a cosmical symbolism" in the buildings of the younger world, and of the intention in the idea of the temple "to set up a local reduplication of the temple not made with hands, the world temple itself." Beginning with the form of the world in the first chapter of his study, the three or four chapters that follow deal with the relation of the building to it as a whole, and the rest of the work with parts and details. The book is an interesting one, the argument is reenforced with citations from mythology and folk lore, and the whole is appropriately illustrated.

In *Philosophy and Physical Science*—an inaugural address as professor in Adalbert College—*Mattoon Monroe Curtis* turns the tables on the champions of scientific culture, and sets forth the claim that "philosophy is the central discipline about which all others cluster, and by which they are to be estimated; that upon the great problems of physical science there is at present little ground for sweeping generalizations and rigid dogmatisms; that principles of faith are the foundations of all our beliefs concerning external realities; that the speculative elements in physical science are its most prominent and necessary features; and that in all speculative questions wisdom commands honesty, moderation, and charity."

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POPULAR MISCELLANY.

Scientific Work of Rochester, N. Y.—A large part of the address of Mayor Curran, of Rochester, to the American Association on its meeting in that city was devoted to the scientific record of the city. While the people showed their mental activity in numerous material applications and business enterprises, he was also able to point with pride to the advances made in scientific research by certain of the population, quietly and without ostentation. The Rochester Microscopical Society was organized in 1879, and has become the largest in the United States. From this beginning sprang the Rochester Academy of Science in 1881. It was divided into twelve sections, including anatomy, astronomy, botany, entomology, conchology, hygiene, ichthyology, infusoria, literature, microscopy, photography, and taxidermy. Its establishment gave a great impetus to scientific work, and afforded the citizens a clearer conception of what was being done. Among individual cultivators of science, Mr. H. C. Maine, editor of a daily paper, has distinguished himself by his careful observations of the sun, carried on through many years, and his theories as to the connection between solar disturbances and terrestrial meteorology. He has successfully photographed the sun and the moon with instruments of his own manufacture, and has gained fame as a microscopist by his arrangement of diatom test plates. Mr. Lewis Swift, another astronomer, "for years, while engaged in the occupation of hardware merchant, devoted every clear night to his favorite study, perched upon an apple-barrel on the near-by flat roof of a rickety cider-mill. Here, while inhaling the pure air of heaven from above, mingled with the fumes of acetic and pomic acids from below, he scanned the skies night after night with an absurdly inferior instrument. But perseverance and love for the science, in the absence of a well-equipped tower, urged him to discovery after discovery, forcing the great astronomers of the world reluctantly to acknowledge the power and genius of the man on the cider-mill." He has been the first discoverer of ten comets, the last one a most remarkable one with twelve tails, and has observed nine hundred and seventy new nebulæ. Rochester is the home of Prof. Ward, the learned biologist, whose labors and undertakings in behalf of science are well known in both hemispheres. It was there, too, that Lewis H. Morgan, anthropologist, lived, labored, and died. The University of Rochester some years ago began teaching anthropology to a small class; other institutions followed the example; but "to this university belongs the credit of having introduced or added in America this important branch to its curriculum." Side by side with scientific labor in the city has grown an optical manufactory which holds a position peculiarly its own. In short, scientific activity has taken deep root in Rochester, and "is there to stay."

The Temperature of the Brain.—From observations made upon animals under various narcotics or anæsthetics, and man, with an instrument capable of detecting changes of not more than 0·002° C., Prof. Moso has found that, as a rule, the temperature of the brain is lower than that of the rectum, but that intense psychical processes or the action of exciting chemical substances may cause it to remain 0·2° or 0·3° higher. An ordinary interrupted current causes a rise in the temperature, which is observed earlier in the brain than elsewhere. Observations made on an animal when awake seem to show that the development of heat due to cerebral metabolism is considerable, and that the mere maintenance of consciousness belonging to the wakeful state, apart from all intense psychical activity, involves considerable chemical action and consequent change in temperature. But the variations of temperature as a result of attention, or of pain or other sensations, are very small; and when an animal is conscious no change of consciousness, no psychical activity, however brought about experimentally, produces more than a slight effect on the temperature of the brain.

Roasted Potato-pulp.—A new method of preparing and preserving potatoes—to be fed to cattle or to be made the basis of dishes for the table—has been devised by M. Aimé Girard, of the Conservatoire des Arts et Métiers, Paris. The potatoes having been ground, the pulp is exposed to pressure for the exclusion of all the water that can be removed by mechanical means. The pulp is then sliced and heated in a furnace till it is entirely dried, at a temperature high enough to give it a pleasant taste, without being so high as to convert the starch into dextrin. The substance thus prepared is called by the inventor torrefied pulp, and is suitable for feeding to cattle. With boiling water it forms a palatable soup; ground and mixed with wheaten or rye flour it forms a good breadstuff.

Saxon Musical Instruments.—According to the report of the Turkish consul at Leipsic, the making of musical instruments has been from time immemorial the occupation of the mountain villages of Klingenthal, Georgenthal, Upper and Lower Lachsenfeld, and Gera, in Saxony, and the instruments are exported to all countries. Musical machines—aristons and orchestrions—are made in Leipsic itself at six factories. Some of the manufacturers in the country at large are famous, like Herr J. Bluthner, who has bought large forests in Galicia and Poland, so that he can provide his own woods. The factories do much work for tropical countries, whither they send instruments the inner parts of which are chiefly of iron. The manufacture of German organs, harmoniums, and accordeons is a specialty of Gera. The manufacture of physical, optical, and medical instruments is one of the special occupations in the forest of Thuringia. For many years the people of Ilmenau, Manebach, and Stutzerbach have devoted themselves almost entirely to the construction of thermometers, barometers, baroscopes, and hygrometers. Whole families are engaged in the work; and children are set upon it from a very early age. It is a surprising sight, on roads distant from the centers of trade, to see whole trains of wagons loaded with physical instruments. The products of this manufacture are much appreciated in Germany. Their construction is perfect; their accuracy is guaranteed by a royal commission at Ilmenau; and many of the universities and doctors supply themselves directly from the country.

Snails of Mountain and Plain.—The influence of the medium on variation has been specially studied by M. A. Locard in the case of land-mollusks, or snails. First among these elements considered is altitude. It seems a simple matter, but is really complicated, and includes among other elements those of temperature, light, ventilation, and food resources, the respective actions of which are hard to separate. The author takes them all in one. The same species of snails are often found at the level of the sea and in the mountains. But the number of individuals greatly diminishes as the altitude increases, under the influence, apparently, of the variations in certain vital conditions. There are species, however, so well adapted to life in elevated situations that they do not thrive elsewhere. The *Helix alpina*, for instance, lives only in the mountains. Though individuals of the species readily and constantly stray into the valleys, they do not form stocks there. As between the species of the mountains and of the plains, the former are smaller, and have thinner and plainer colored shells. With increase of heat, below the degree of intensity at which existence is threatened, the size increases. Many species attain double the size they reach in France, while species transported from Algeria to France shrink to one fourth the dimensions they have in their native habitat. The character of the shell is affected by variations in the soil. Calcareous districts are rich in mollusks, while those in which the soil is silicious are poor in them, and the animals themselves are smaller and less vigorous. The difference may be experimentally verified by feeding half a lot of snails upon plants growing in sandy ground and the other half with plants from calcareous soil; a great difference will be perceived in the size of the shells.

Size and Shape of Rain-drops.—Mr. E. J. Lowe has made more than three hundred sketches of rain-drops, and has gathered some interesting facts respecting their variation in size, form, and distribution. Sheets of slate in a book form, which could be instantly closed, were employed. These were ruled in inch squares, and after exposure the drops were copied on sheets of paper ruled like the slates. Some drops produce a wet circular spot; while others, falling with greater force, have splashes around the spots. The same drop varies considerably in the amount of water it contains. The size of the drop ranges from an almost invisible point to at least two inches in diameter. Occasionally large drops fall that must be more or less hollow, as they fail to wet the whole surface inclosed within the drop. Besides the ordinary rain-drops the author exhibited to the Royal Meteorological Society diagrams showing the drops produced by a mist floating along the ground, and also the manner in which snow-flakes, on melting, wet the slates.

Geographical Work of 1891.—In his annual address as President of the Royal Geographical Society Sir Montstuart E. Grant Duff, reviewing the incidents of the geographical exploration accomplished during the year, noticed Mr. Merzbacher's work in the Caucasus and Mr. Howell's ascent of Oraefa Jökull in Iceland as the chief mountaineering feats. In Asia military exploration had gone on steadily on the northern frontiers, and the society was making efforts to have the results of such work made more accessible to the public. Lord Lamington's journey in the Shan states, and Captain Bower's and Dr. Thorold's adventurous crossing of Thibet also opened up new ground. In Africa, Mr. A. E. Floyer crossed the Egyptian Desert from Assouan to the Red Sea; and in the region of the Great Lakes Captain Lugard, Emin Pasha, Dr. Stuhlman, and the late Father Schynse have added to our knowledge. The Italians have been energetic in exploring Somaliland, and the French, despite the disaster to M. Crampel, have not abandoned their efforts to reach Lake Tchad from the west. Captain Gallwey and Mr. Gilbert T. Carter have made important discoveries in Lagos and Benin. Mr. Bent's well-known exploration of Zimbabwe, and Mr. Joseph Thomson's study of Lake Bangweola, which ill-health still prevents him from writing up, are the most important pieces of work in South Africa. Sir William MacGregor has been very active in opening up British New Guinea.

The New Element Masrium.—The probable existence of a new element is reported in the *Chemiker Zeitung.* It occurs in a mineral which was discovered in 1890 by Johnson Pasha in the bed of one of the dried-up old rivers of Upper Egypt—a fibrous variety of a mixed aluminum and iron alum containing ferrous, manganous, and cobaltous oxides; in addition to which is a small quantity of the oxide of another element, having properties different from those of any yet known. The supposed element has been named *masrium* (Ms), from the Arabic name for Egypt, and the mineral masrite. Its atomic weight has been approximately determined at 228, which nearly corresponds with the number (225) for which an element is wanted by the periodic system in the beryllium-calcium group. The monoxide has been obtained, and several salts.

Personality in Animals.—We are accustomed to take but little account, says *Le Monde de la Science et de l'Industrie*, of the possession of a sense of personal responsibility by animals, but if we look carefully into the matter we shall find that it is an important trait among many of them. Many animals know how to impose rules of conduct upon themselves, to assign themselves duties, and to observe them. Their females attend to the wants of their young before securing their own provision of food; the sentiment of the relations of command and obedience is obvious in social animals, like monkeys, deer, elephants, buffaloes, and birds of passage. The shepherd-dog controls the flock that is intrusted to his care with as much authority and self-confidence as his master himself. The imposition of restrictions upon themselves exists among animals to the extent that is necessary for the maintenance of their health. Capacity to adapt its work to the laws of Nature is perceptible in the bird building its nest, as it is in the architect who is constructing a monument. The fox is a skillful constructor of the kind of burrow best adapted to its needs. All these animals exercise a precise action upon their medium for a definite purpose. Dogs seem to have complete consciousness of their existence, and their slightest actions accord with that view. They hunt with as much ardor as men, and seem to take a genuine interest in incidents of the expedition; they prance with joy when successful, and drop their tails after failure. What right have we to deny them consciousness? The rudiments of what we regard as the real bases of personality certainly exist, in a more or less marked degree, in even the inferior animals. If man is a person and derives rights and duties from the fact, so also, to a certain extent, are the elephant, the dog, and the fox, each in its way. It is easier to talk about the gulf that separates man from the other animals than to measure it.

Soldering Metals to Glass.—According to the Pharmaceutical Record, an alloy of ninety-five parts of tin and five parts of copper will connect metals with glass. The alloy is prepared by pouring the copper into the molten tin, stirring with a wooden mixer, and afterward remelting. It adheres strongly to clean glass surfaces and has the same rate of expansion as glass. By adding from one half to one per cent of lead or zinc, the alloy may be rendered softer or harder, or more or less easily fusible, as required. It may also be used for coating metals, to which it imparts a silvery appearance.

Age of the Central American Monuments.—As a result of his studies of the monuments of Central America and Yucatan, Mr. Alfred P. Mandelay announces in Nature the conclusions that the southern ruins, including Palenque, Copan, and Quirigua, are much more ancient than those of Yucatan, and were probably in full decay before the Spaniards entered the country; while in Yucatan, where the Spaniards first came in contact with Indians who used stone as a building material, some of the ruined structures now to be seen were inhabited by the natives at the time of the conquest. The author believes that the civilized portion of the Maya race have at some time occupied all the country lying between the Isthmus of Tehuantepec and the western frontiers of Honduras and Salvador, excepting perhaps a strip of country along the Pacific seaboard; that this people spoke the same or nearly allied languages, which they wrote or carved in the same script; that they were followers of the same religion; and that they built stone-roofed temples and houses decorated with the same class of design and ornament. At the time of the Spanish conquest they had abandoned their towns and religious centers south of Yucatan, though from the present condition of the mines it could not have been many years before; while in Yucatan, where they probably still occupied some of the buildings, they were in a state of decadence, and many of the larger centers of population had been abandoned, although the more important religious edifices may still have been reverenced and kept in repair. The early Spanish writers speak of large numbers of books written and preserved by the natives of Yucatan. They were written in the Maya language, and in characters called hieroglyphical. The Spaniards destroyed all of these books they could, thinking them the work of the devil, but copies of three of them escaped, and are preserved in European museums. The characters in which they are written are similar to those of the inscriptions on the monuments; and both are believed to be in a language that is still living and spoken in the region, although it has probably been much changed in the course of years.

The Sargasso Sea.—A theory of the Sargasso Sea is proposed by M. Krümmel, different from that of Humboldt, which was based, he avers, on less complete observations than we have now. This sea is in the form of an ellipse with the major axis nearly following the tropic of cancer. Around the principal ellipse are other larger ones, in which the vegetation is not so thick, and the forms of which are affected by prevailing winds. M. Krümmel believes that the sea-weeds come from the shore regions of the Gulf of Mexico, the Antilles, Florida, and the Bahamas, and not from the bottom of the sea, as was formerly supposed, and is in this supported by recent observations of the Gulf Stream. This current is now believed to be the resultant of numerous currents coming from the Antilles, and therefore to carry a much larger quantity of sea-weed than was formerly supposed. These sea-weeds reach the Sargasso region in about fifteen days after they enter the Gulf Stream. They are carried slowly onward toward the Azores till they become water-logged and sink, to give place to others.

Secular and Periodic Changes in Latitude.—A committee appointed by the American Association to secure data with regard to secular and periodical changes in latitude, reported that the investigation could best be made in a method suggested by Prof. S. Newcomb, of observations at three stations somewhere near the same parallel of latitude, but in widely different longitudes; the observations to be extended over a sufficient interval of time to secure the elimination of any effect arising from the recently discovered short-period variations in the latitude. Such a series of observations, followed after an interval of from ten to twenty years by another similar series, would furnish suitable evidence on the subject. It seems advisable also to utilize as far as possible some of the older determinations of latitude at American stations, particularly the Bond-Peirce determination at Cambridge in 1845 and the earlier Coast Survey determinations. New observations are already promised at Cambridge and Washington. The more detailed recommendations of the committee, in harmony with these views, were approved by the Association.

Remedies for Defective Color-vision.—A committee of the Royal Society appointed to consider the question of testing for defective color-vision has made a report recommending that a schedule be made of employments in the mercantile marine and on railways, the filling of which by persons whose vision is defective, or who are ignorant of the names of colors, would involve danger to life and property; that the testing should be compulsory, and intrusted to examiners certificated by the central authority; that Holmgren's test be used for color-vision, and that after passing it the candidate be required to name without hesitation the colors that are employed as signals or lights, and also white light; that rejected candidates have a right of appeal; that candidates rejected for naming colors wrongly who are proved to possess normal color-vision be allowed to be re-examined after a proper interval of time; that certificates of the qualifications of candidates be given, and schedules of the results of examinations be sent up every year; that persons filling the scheduled employments be examined every third year for form-vision; that the tests, etc., be inspected periodically; that signal colors of ships and railways be as far as possible uniform; and that witnesses in judicial inquiries arising out of these matters be themselves tested for color and form vision.

A Curious Accident by Lightning.—A singular wholesale effect of a stroke of lightning occurred at Bourges, France, on the 4th of May. A detachment of soldiers was hastening to get under shelter from an approaching storm, when the whole body were thrown by the lightning upon their faces. One man, who was a little distance away and in the rear, was also affected, but not so seriously. Most of the men rose immediately, but four remained prostrated for a little while, and one was killed. The men say they felt violent blows in the nape of the neck and the legs, and a sensation of burning. None of the men saw the lightning, except an officer in front, who was facing them.

Types of Indian Beauty.—In an interesting paper on Indian Types of Beauty, Dr. R. W. Shufeldt has collected portraits, with personal descriptions, of specimens representing several tribes of the Southwest, including a Navajo man and his wife Anserino; Izashima, a belle of the Laguna Pueblo; the daughter and the wife of Paliwahtiwa, governor of Zuñi; a girl of Moqui; Natuende, an Apache maiden; Sowatcha and Luli-pah, married Mojave women; and a Yuma squaw. The Yumas never have as good-looking women among them as are to be found among the Mojaves; and, in the author's opinion, "the prettiest and most intelligent faces of all are possessed by the young unmarried girls of the pueblos."

Kerosene as a Preventive of Mosquitoes.—Mr. L. O. Howard, of Washington, read an interesting paper before the Association of Economic Entomologists in Washington, on averting the mosquito plague by treating the breeding-spots of the pests with kerosene. He gave the details of some accurate experiments made during the first part of July, which indicated that ninety-six thousand square feet of water can be covered by one barrel of kerosene, at the cost of $4.50. The effect of the treatment is that the eggs and early stages of the mosquito are destroyed, and all the female mosquitoes alighting upon the surface of the water for the purpose of laying their eggs will be killed. The deadly effects on insects of such application will remain for at least two weeks, and will outlast all evidence by the smell of the presence of kerosene.

NOTES.

A committee of five members, chosen from different sections, was appointed by the American Association to act with the corresponding committee of the World's Congress of the Columbian Exposition respecting such matters as may appropriately come under its cognizance.

The report of the American Association's committee on indexing chemical literature recommends that communications be entered into with the Royal Society, so that a perfect index can be prepared. It was decided to appoint a committee to secure a certain number of experts to work on the index which is to be published by the Smithsonian Institution.

The credit for the introduction of manual training into the public schools is claimed by Director J. L. Tadd, of the Public Industrial Art School of Philadelphia, for Mr. Charles G. Leland, who was chiefly instrumental in influencing the board to make the first attempt. Mr. Leland was a skilled handworker as well as literary man, and had a complete idea of the practical side of the question as well as of the theoretical. The teachers in the Philadelphia school think the results in their general studies are improved by the relaxation and change given by manual-training work in and between their own studies.

Prof. W J McGee adduced a considerable number of reasons at the Niagara Falls Excursion of the American Association for supposing that the recession of the Falls from Lewiston to their present position has occupied about seven thousand years—he regarding Prof. N. H. Winchell's estimate of seventy-eight hundred years as probably the best. "On comparing this estimate with the march of the secular seasons," he says, "a remarkable coincidence is observed; for, since the longitude of perihelion is now 99° 30′, the middle of the last Platonic winter, which is now just past in the southern hemisphere, occurred seventy-one hundred years ago. This coincidence strengthens the suggestion of interdependence between cosmic and terrestrial conditions, and affords a basis for comparing the natural time-unity of the astronomer with the semi-arbitrary periods of the geologist; and so the date of the last ice invasion recorded in the moraine-fringed glacial deposit may be provisionally fixed at seventy-one hundred years ago."

In his address before the Anthropological Section of the American Association on The Evolution of the Æsthetic, Mr. W. H. Holmes maintained that creations of art are growths the same as are the products of Nature, and are subject to the same inexorable laws of genesis and evolution. The several branches of æsthetic art—painting, architecture, sculpture, music, and the drama—were reviewed, and their growth and evolution illustrated in support of this thesis.

The American Association decided to ask Congress for a reduction of the tariff on scientific instruments and periodicals; also to ask it to take steps for the preservation of the ancient ruins which are situated on Government lands.

Dr. H. Molisch, after investigation of the subject, denies that iron is present in chlorophyl, having never found a trace of it in that substance. He says that iron occurs in plants in two forms—in that of ordinary iron-salts, and in the "masked" condition, in which it is so closely combined with organic substances that the ordinary reagents fail to detect it. In this form iron occurs both in the cell-wall and in the cell-contents, but does not enter into the living protoplasm.

The experiments of Mr. A. J. Cook, of the Agricultural College of Michigan, appear to show that bees require eleven pounds of honey to enable them to secrete one pound of wax.

The statement of Mr. George F. Kunz, that the hardness of diamonds is not perceptibly reduced by cutting and polishing, is confirmed in Science by Mr. W. A. Rogers, of Colby University, who has had much experience in ruling with diamonds.

According to a paper by T. Forster, of Amsterdam, the bacteria which produce the light of phosphorescence are able to multiply and develop at the freezing-point of water. They not only live in the sea, but are met with in brackish and fresh water, upon victuals, manures, etc. This agrees with the fact that victuals kept for some days in an ice-chamber gradually assume a disagreeable smell and taste; and that meat can be preserved from putrefaction for days, but not for weeks. If foods are to be preserved at a low temperature for a long time, besides cold, a second element is necessary—dryness.

Dr. H. J. Tylden, of England, has recently died of typhoid fever, after having been engaged in investigations of the etiology of the disease—in which, it is supposed, he contracted it. He had recently published an article in Nature on The Bearing of Pathology upon the Doctrine of the Transmission of Acquired Characters.

A wild-flower exhibition—the fourth of the kind—was recently held in Edinburgh, Scotland, and is described by Mr. W. R. Lazenby in Garden and Forest. It comprised seventeen hundred entries, including hand-bouquets, baskets, bouquets of heather and thistles, of heather and bluebells, of wild grasses, of white heather, of wild ferns in rustic baskets, wreaths of wild roses and honeysuckles, collections of dried wild flowers and of dried leaves of native trees tastefully mounted, crosses of wild flowers, and window flower-boxes. All, with the exception of the last class, was the work of children. The exhibition is given under the auspices of a juvenile paper of the city.

A correspondent of the London Spectator tells of a horse in India which lately defended its master and saved his life against a murderous attack made upon him. Lieutenant Robertson, of the Engineers, when out riding, was joined by a Ghazi—which is Oriental for champion—entered into a friendly conversation with him, then into a race—and beat him. The Ghazi then attacked the English officer with his *tulwar* and inflicted a severe gash upon his neck. "When Lieutenant Robertson fell off his horse, and was lying on the ground bleeding profusely, the faithful animal protected his master from further injury by kicking at the Ghazi and attempting to bite him. But for this remarkable behavior on the part of Lieutenant Robertson's horse, it is supposed that the Ghazi would have probably hacked Lieutenant Robertson to death." The Ghazi was seen by two Indian boys, was caught and identified, and sentenced to be hanged.

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