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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*EDWARD ORTON, EDUCATOR.**

I RESPOND this afternoon to a summons difficult to obey but impossible to deny. I am reluctant to undertake what could be done so much better by others, but it is impossible for me to decline to join in doing honor to the memory of one whom I so much loved and admired, however feeble and inadequate my words may be.

My association with Dr. Orton extended through a period of nearly thirty years. Beginning as a casual acquaintance, such as is common among men engaged in the same occupation, it rapidly ripened into a friendship which, happily for me, grew in strength with the years as they passed. My most intimate personal relations with him existed during the earlier years of the Ohio State University, the institution to which he gave so large a share of his life's work, and which to-day makes fitting acknowledgment of the value of that work and of the irreparable loss which it has sustained in his death. Of Dr. Orton as one of the most eminent of geologists of his time, of the splendid example which he set in the performance of the duties of plain citizenship, and of the many other striking characteristics of a career which is rarely paralleled, others will speak, and I will re-

*Read at a Memorial Meeting, Columbus, Ohio, November 26, 1899. A portrait of Orton was published as a frontispiece to the issue of SCIENCE for September 1, 1899.

strict myself, therefore, to remarks upon his earlier work in this university and his influence as an educator rather than as a specialist.

I firmly believe that no one can fully understand and fairly evaluate Dr. Orton's services to the university during the first ten years of its existence who was not himself in some way or other a part of its official organization during those years, and in close touch with methods and motives by which its future career was determined, and I must ask your indulgence in a brief statement of some of the conditions under which the institution came into existence.

The Act of Congress which created this and many other noble institutions of learning, having been passed in the most discouraging and gloomy year of the great Civil War, did not receive immediate consideration and acceptance by many of the States, and in Ohio there was a delay of nearly ten years before those interested saw definite promise of the actual realization of their hopes. In the meantime and during the latter part of this period there was much necessary and useful discussion in regard to the character and scope of the proposed school. Innumerable schemes for utilizing the prospective income were thrust upon the public, and there was much strength in support of a division of the fund among several existing institutions. The first board of trustees courageously resisted all attempts to destroy by disintegration, and it was finally determined that the institution should be located at Columbus and known as the Ohio Agricultural and Mechanical College.

The field of controversy was now greatly narrowed, but was, perhaps, correspondingly more intense. The character of the work of the new school, the scope of its courses and their relation to the requirements of a liberal education were yet to be determined. On the one hand were those who urged a generous interpretation of the Act of 1862, and who believed that it was primarily intended to furnish the foundation of an institution which might in time become a great university for all of the people; that while, in the provisions of the Act the nation had determined to fortify and invigorate the two great sources of the State's material prosperity, agriculture and manufactures, especial emphasis had also been placed upon the importance of fostering the more purely intellectual or culture components of a well-rounded course of study, for it was specifically directed that these must not be neglected. On the other, was a considerable group of men, equally honest, conscientious and well meaning, who wished to organize a school, intensely practical in tone and atmosphere, in which even science would have found no place except as applied science, and which would have offered little opportunity to those—and, fortunately, they are many—who seek to show their right to labor in the higher regions of more purely intellectual activity. Both sides of this most important controversy were represented by strong men in the first board of trustees, and it is but justice to all to say that the conflict was waged in a manner worthy of the dignity of the occasion and of the great trust for which they had become responsible. I cannot here even refer to the various phases of this discussion or to those who were most active and influential in shaping the organization of the school, nor can I omit saying that to the first president of the board of trustees, Valentine B. Horton, and to Joseph Sullivant, then and long one of the leading citizens of Columbus and of Ohio, the University will ever be indebted for the exercise of a courage, tact and unwearying effort that went far to put the institution in the way of being what it has been, is, and is sure to be in the future. Fortunately, they were supported by many others of the board, who, in themselves, represented liberal culture, combined with a genuine democracy of feeling and a loyalty to the Commonwealth, compelling the belief that nothing was too good for the children of the people.

The issue was made and met in the appointment of the first faculty of instruction; and in the selection of the first presiding officer fortune was singularly favorable to the new school. A professor in a New England college who has received the highest political honors his State could confer upon him had been invited to become the president of the college, but circumstances arose which made his acceptance impossible. Dr. Orton had been in Ohio only a few years, but he had become widely and well known, not only on account of his accomplishments as a geologist, but as well by his charming personal qualities, and he had been already chosen to fill the chair of geology. To him the trustees now turned, and he reluctantly consented to be the first president of the Ohio Agricultural and Mechanical College. I say reluctantly, for it was well known among his friends and associates that he was loath to assume administrative duties which must necessarily interfere with the continued pursuit of his specialty in which he was already recognized as an authority. Happily for the institution he yielded his personal preferences, and for eight years he was at once president and professor.

Among the several thousand young men who crossed college thresholds in Ohio in the autumn of 1873 seventeen entered the building in which we now are, and enrolled themselves as students, the first of the many thousands who have since followed their example. I cannot describe and few can appreciate the many trials and difficulties of those earlier years. The institution was practically unknown, even among those from whom its patronage was most likely to come. It stood for a new departure in education which was just entering upon its experimental stage, and with few exceptions it was looked upon with suspicion by other colleges in the State. The members of its first faculty, of whom only four are now living, were mostly young men, full of ambition and enthusiasm for their work and thoroughly in harmony with the spirit of the time, for even then had come the dawn of the marvelous last quarter of the wonderful nineteenth century, a period during which, short as it is, the relation of man to the material universe to which he belongs has undergone a far greater change than in any other period in history. It is often, indeed generally, possible in looking backward upon things accomplished to see many mistakes that might have been avoided and many opportunities not properly utilized. As I review, however, the principal events of Dr. Orton's presidency of this institution I am at a loss to say, even with the better knowledge that accompanies retrospection, how the many emergencies that presented themselves could have been met more wisely. To begin with, his standard of educational work was of the highest type. He fully realized that the success of the institution depended on the establishment and maintenance of a standard of scholarship so high as to compel the respect of the best educational forces not only at home but abroad. Himself a scholar in the broadest, best and most exacting sense, he encouraged faculty and students to seek the best ideals, and no one of them who gave the slightest indication of the possession of the *divine afflatus* in learning ever failed of appreciative recognition from him. He believed that the character of an educational institution should be judged by the quality of its work rather than by the number of students enrolled in the annual catalogue, a principle which everybody admits and nearly everybody ignores. To stand up for it and do it, especially during the early struggling years of a college, demands a courage that few possess. That Dr. Orton did this, even under the most trying conditions, I set down as, on the whole, the most notable characteristic of his career as president. For I am thoroughly convinced that if he had chosen to do otherwise, if the doors had been opened wide, at both ends of the curriculum, the institution would have long since sunk into a deserved oblivion.

Few college presidents have so continuously received the loyal support and sympathy of their colleagues in the faculty as did Dr. Orton. A college faculty is not likely to shine as an example of meek and amiable submissiveness, and this is particularly true of one composed, as this was, and many are to-day, of specialists. Twenty-five years ago, and earlier, it was usually believed that a college professor might fill any chair that happened to be vacant, and indeed more or less regular interchange of duties was often regarded as highly desirable. The passing of the era is to be attributed in a large measure to the example and influence of institutions of which this is a type. The specialist, however, is tolerably certain to hold that his own particular department is of far greater importance than any other, and he may be relied upon to desire and demand a large share of available resources to aid in its development. Upon the president falls the by no means agreeable task of apportionment and restraint, and this duty was discharged by Dr. Orton with rare discrimination, fairness and tact. No mere administrator, however skilled in that capacity, could have done as well. His scholarship was thorough and yet broad enough to enable him to know what was being well or indifferently done in every department, and is there not a freemasonry among scholars which makes mutual recognition easy even when there is no common language? I am reluctant to refer to my own personal experience on an occasion which is completely filled with one personality; but I can never forget the many instances in which I received from him encouragement in the way of sympathetic acknowledgment and often praise, for work which was doubtless trivial and unimportant, but the recognized success of which served to keep alive the fires of ambition, enthusiasm and interest.

Of Dr. Orton's relations to the students, whose numbers multiplied many times during his presidential period, it is hardly necessary to speak. Too often the president of a college is unfortunate in that he rarely comes in close relations with students except to administer reproof or define restraint. The discipline of this college in its early years was nearly as great a departure from accepted traditions as were its methods of instruction. A large degree of freedom was allowed without the asking, but the line separating liberty from license was sharply defined. It was intended to cultivate a spirit of manly self-reliance together with a full knowledge of the responsibilities of citizenship, and the administration of the few simple regulations was always so just and fair that no ground for complaint could be found. In this as in all his relations with others Dr. Orton believed in the efficacy of reason and in the doctrine that it is generally more important to convince a young man that he has done wrong than to punish him for so doing. He was slow to condemn and reluctant to punish, but I have known few men more inflexible and unflinching when a vital principle was contested. He won the confidence of all with whom he came in contact, and young and old valued his judgment, and advice. As a teacher he was most inspiring. His literary and linguistic powers were unusual, and he easily made any topic attractive, even to the dull. From hundreds of his pupils comes the testimony that to him they owe the first quickening of their intellectual life, the earliest revelation of their own moral obligations and responsibilities. There can be no higher praise than this.

Complete as was Dr. Orton's success in everything concerning the internal management of the college, his services as its representative in all its relations to the outside world were of far greater importance. The young institution was but coldly received at first, and this was especially true among those who ought to have been its friends. There were numerous harsh and unjust criticisms of its course of study, its faculty, its board of trustees, and it was even attempted by a few men of influence to make it a football of partisan politics, so that its organization might be completely changed with every change in State administration. Against these and many other adverse conditions its board of trustees, president and faculty had to contend. The confidence of the people had to be won and was won, largely by the strenuous but tactful efforts of the president. An eloquent exponen tof the progress of scientific thought, in more departments than one, Dr. Orton was everywhere welcome upon the lecture platform. In cities, towns and villages, in grange and farmers' institute, in teachers' convention and literary society, whenever men and women met to foster intellectual growth, he was heard with delight and approbation. His speech was choice, yet simple, clear and dignified, often rising to an eloquence, never of sound or mere words, but of noble thought. Fortunate, indeed, was the new college in having so splendid an exponent, and it is not strange that gradually but surely there came to its support a large and influential constituency from among the best people of the State.

Nor was there any lessening of his influence in its behalf when, after several attempts and against the wishes of the friends of the college, he induced the board of trustees to relieve him of administrative duties and allow him to devote his entire time to his professorship. After that time much of his most important scientific work was done, and as State geologist he became, even more than before, familiar with every nook and corner of the State. His broad democracy of spirit and his generously helpful disposition combined to put him in close touch with the great industrial interests of Ohio, including man as well as matter. He knew the miner as well as the mine, and it would be difficult to measure the value to the university of his almost unique relations with the productive forces of the Commonwealth. The beautiful and noble building which bears his name, and which, from this time on, will stand as a monument to his memory, bears witness, in the very stones of which it is composed, of the readiness with which these forces responded to his touch.

But still more enduring will be the traditions of his life and work in and about this institution, his charming personality, his felicitous speech, his lofty moral and intellectual ideals.

His title to high, perhaps highest, place among the great benefactors of the university, those who by wisdom and tact first made its existence possible and afterward its destruction forever impossible, rests upon a foundation as solid as that of the rocks he so much loved.

" Say not of me that I am dead," were the last words of a great English poet; " Say not of him tha the is dead " are our words to-day; speaking for the few who have been privileged to enjoy the most intimate personal friendship, as well as for the many, scattered over this broad land; for all our lives have been better and will be better because of their having intermingled with his.

Thomas C. Mendenhall.
Worcester Polytechnic Institute.

EDWARD ORTON, GEOLOGIST.*

It was in the autumn of 1869, just thirty years ago, that I first met Dr. Orton. In that year the Second Geological Survey of the State was inaugurated under the directorship of the late Professor Newberry; Governor Hayes named Dr. Orton as one of the two principal assistants for which the law made provision; and it was my own privilege to be accepted, at the same time, as a volunteer aid. In the arrangement of duties Dr. Orton took charge of work in the southwest quarter of the State, and Dr. Newberry gave chief attention to the northeast quarter. Being assigned to Newberry's corps, I had no opportunity to meet Dr. Orton until late in the season, when I had the good fortune to be bidden to attend a conference of the chiefs at Columbus. While on the journey from Cleveland, Newberry prepared me for the meeting by sketching the quality and character of his colleague—a man without guile, direct in his conversation, and absolutely transparent as to motive. The simplicity of manner which would impress me at the start was not of manner merely, but was a fundamental trait coördinate with, and not contradicted by the wisdom which made him a man of affairs. His sensitive conscience making him peculiarly careful to adhere to the facts of observation, he was cautious and conservative in all his geologic work.

Newberry's description naturally made a strong impression, and in the conference that followed it is probable that I gave as much attention to the man as to the subjects of discussion. Certain it is, that the geologic themes have vanished from my memory, while the picture of the man remains. In later years, as we met from time to time, as I listened to his voice in public address or read the papers that emanated from his pen, I was able to add here and there a detail which Newberry's sketch had failed to delineate, but no line of it was ever erased, and Orton has remained for me one of the safest and most open-minded of investigators and the simplest, kindliest, and most lovable of men.

To what extent considerations of historical fitness may have determined the arrangement of to-day's exercises I do not know, but certainly there was peculiar propriety in giving first place to Orton's work as an educator. During the first half of his period of intellectual activity education was the primary theme, and it was only in later years that geology assumed prominence. We are told that his first geologic observation was undertaken with the distinct purpose of increasing his efficiency as a teacher of geology, and in his early acquaintance with rocks and fossils his point of view was educational. Interest in geologic studies for their own sake was a matter of development, and many years elapsed before it assumed control in the determination of his fields of activity. This peculiarity of his introduction to the science in which he finally achieved distinction had much to do with the quality of his scientific work and scientific writings.

It determined, in the first place, that he should not specialize at the beginning of his career. In geology, as in medicine, there are general practitioners, broadly versed in the principles and particulars of the science, who are prepared to undertake and conduct investigations of great variety; and there are specialists, each devoted to some minor branch of the general subject, in which he works intensely and exhaustively. The specialist, restricting his attention thus to

* Read at a Memorial Meeting, Columbus, Ohio, November 26, 1899.

a narrow field, is almost necessarily a somewhat narrow man, and while his concentration of effort may lead to important results altogether unattainable by the general student, he is subject to great danger from lack of balance. The teacher of geology is compelled by his vocation to acquaint himself with all branches of the science, so that his view is necessarily broad, and if he is also an investigator in a special field he is comparatively exempt from the recognized dangers of specialization. Orton's early work as teacher and observer gave him the broad view. When he first became known to the scientific world as an investigator he was recognized at once as a general practitioner or all-around geologist, and when, in later years, his field was somewhat restricted and he became an expert in a special department, there was no danger that his narrow view would blind him to the recognition of the broader relations.

In somewhat similar way the method and phraseology of his scientific writings were determined by the compound character of his career. As a teacher he was called upon to present the principles of his science to beginners in scientific study; as a lecturer to popular audiences he was accustomed to the communication of scientific ideas in untechnical language; and as executive officer of academy, college and university he had constantly to deal with men of affairs untrained in the technicalities of science. Thus ever in touch with the lay mind he was in no danger from the literary pitfalls which beset the recluse and the specialist. He wrote for the people in language which they could understand, and even when presenting his scientific conclusions to brother geologists he found little need for those technical terms which are so apt to render science unintelligible to the general reader.

The manner of his introduction to the work of scientific investigation had its influence also on the quality of his work. As most of my audience are well aware, scientific investigation, or the endeavor to understand nature, consists of two parts, observation and theory. We open our eyes to the facts, or phenomena, as they are called, of nature, and make record of what we see, and then we endeavor to explain the phenomena by discovering how they have come to be. We observe and we theorize. But while observation and theory may logically be distinguished, in practice they must be intimately combined or the best results are not secured. There are, indeed, observers who take little cognizance of theory; but the best observers have theory constantly in mind, and through consideration of the relation of their facts to theory have their vision sharpened and their attention guided to those things which are most important. And there are theorists, too, who are indifferent to facts, soaring untrammeled in the realms of imagination and speculation. But the successful theorist tests every hypothesis by scrupulously comparing it with the phenomena to which it pertains, and modifies or rejects it when he discovers a discordance. It is by the observer who is also a theorist, and the theorist who is also an observer, that real progress is achieved.

As a teacher Orton derived from the literature of geology a body of theory which he complemented, so far as practicable, by personal observation of the rocks, minerals and fossils that lay within his reach. Thus he trained himself early to habits of observation, and in all his later work kept in close touch with the phenomena of nature. As an investigator he generalized freely and did not shrink from the propounding of theories, but all his theories were so broadly founded upon, and so faithfully verified by, the phenomena of observation that they came to the world as demonstrations which could not be gainsaid.

This far we have considered only Orton's work in pure science, but his work in applied science was of equal or greater importance, and it was in this field that his personality was most marked. I trust that you will bear with me in another digression at this point, for his life serves to illustrate certain peculiarities of the relation of man to science which are not always kept clearly in view.

It is a matter of common understanding that scientific knowledge, or knowledge of nature, is the foundation of the material progress of the race, but the method through which it serves this purpose is perhaps less broadly understood. Through research the body of 'natural knowledge' has been created and is constantly increased. This body of knowledge is a storehouse from which men may draw that which they find useful, and from which they do, in fact, make drafts at every stage of progress. But the store of knowledge grows quite independently of the drafts which are made upon it. The utility of the individual grains of knowledge is not foreseen, and their accumulation is always much faster than their utilization. So far as we may judge the future by the past, only a small portion of the garnered knowledge will ever find practical application, and thus, from the purely utilitarian standpoint, there is an immense waste of energy in the prosecution of research. This only illustrates the general fact that mankind is a part of nature, for in nature the ways of progress are ever wasteful. The acorn is nature's device to prevent the extermination of the oak, and an oak tree in its long lifetime produces a myriad of fertile acorns, but only one of these, on the average, escapes all the dangers of immaturity so as to develop a perfect tree; the others fail for lack of opportunity, and, so far as the continuance of the species is concerned, are wasted.

The gathering of this great store of natural knowledge, only part of which can serve the purposes of mankind, is called pure science. The utilization of such portion as may be found available constitutes applied science. If the practical ends of applied science constituted the only motive for labor in pure science, mankind would be appalled and discouraged by the enormity of the waste; but, fortunately for human progress, another motive exists in the love of knowledge for its own sake.

Every activity which is so often repeated as to become habitual affects mental constitution and may result in a corresponding sentiment, appetite or instinct, which in turn becomes a motive for the activity. Take, for example, the fundamental act of eating, which is essential to preservation of life and is common to all animals. There has been developed in connection with it a desire to eat, or appetite, which for most sentient beings is the actual motive, there being no perception of the relation of food to life. Men associated in communities find advantage in the classification and division of labor so that each shall perform some one function for others as well as for himself, being repaid through equivalent service by others. In order to exchange labor, or the products of labor, good faith is necessary, and coöperative living has accordingly developed the sentiment of honesty. Moreover, as industrial organization makes each individual continually work for others more than for himself, there is developed in him a sentiment impelling him to do for others, the sentiment of altruism. Again, the importance of social aggregation in the evolution of all phases of human culture has led to the creation of great nations, and national existence has engendered national sentiment, the sentiment of patriotism, but the masses actuated by patriotism as a motive have little conception of the value of aggregation as a factor in human development.

In a similar way scientific research as an essential to material progress has developed its own sentiment, the scientific sentiment, or the sentiment of acquiring knowledge for its own sake, and this is the motive of pure science. As honesty, altruism and patriotism are sometimes carried to absurd limits, so as even to oppose the ends they normally tend to promote, so the scientific sentiment is liable to perversion; and there are not wanting scientists so devoted to the acquisition of knowledge that they are impatient of its application, and look with disdain on other scientists who strive to discover its uses.

In the application of natural knowledge to human uses material gain is usually in sight, and this supplies a motive so distinct from the unselfish sentiment of science that the same individuals are rarely votaries of both pure and applied science. Taking an illustration from the branch with which I am most familiar, the mining engineers, occupied with the application of geologic knowledge and actuated primarily by the motive of material gain, are a distinct body of men from the geologists proper, occupied with the acquisition of geologic knowledge and actuated primarily by the scientific sentiment. There are, indeed, individuals who perform both functions, but as compared to the general body they are rare exceptions. Such an exception was Edward Orton, and he stands prominent among geologists as one actuated by altruistic motives not only in the acquisition of knowledge but in its application. Selecting, by preference, the geologic problems connected with the useful minerals stored in the strata of his State, he carried his work not merely to the inductions and theories of pure science but to practical utilitarian applications, and these were freely given to the community he served. Through official reports, through the columns of newspapers, and through personal conversation he imparted not only statistical information and general principles concerning the occurrence of ores and mineral fuels, but practical and timely advice as to their exploitation and conservation. Employed by the people, he labored for the people, and he gave them the bread for which they asked.

Orton's work in geology, so far as it is a matter of record, is largely connected with the survey of this State [Ohio.] For thirty years he was an officer of the State, and though not continuously engaged in its service nor always compensated in money for the work which he performed, it is believed that he devoted more time to its exploration and survey than any other geologist, and that his knowledge of the distribution, qualities and structures of its rocks was correspondingly intimate and comprehensive. His reports are so numerous and extensive and pertain to so wide a range of topics that I shall leave their enumeration to the biographer and bibliographer* and content myself with a simple outline.

An assistant geologist under the directorship of Professor Newberry he began work in 1869 in the southwest quarter of the State, called the Third District, and his labors were confined to this field for a number of years. Gradually, however, they were extended to coal fields farther east, and after the year 1882, when he practically assumed the functions of geologist in chief, the entire State was within his purview. He was also engaged for shorter periods in the investigation of oil and gas fields of Kentucky, Indiana and New York, and he made reports to the United States Geological Survey and to the Eleventh Census of the United States on various economic resources of Ohio and Indiana. His contributions to pure science were in part published by the Geological Society

* A list of scientific papers will appear in volume 11 of the Bulletin of the Geological Society of America.

of America and by various scientific journals.

Among his writings are many discussions of the character, sequence, extent and arrangement of the geologic formations underlying the State, and also of the deposits of drift which mantle the surface. He described in detail the geologic features of many counties, and he worked out and published the structure of most of the coal fields of the State, discussing not only the relations and extent of the seams, but their practical qualities. During the last two decades he gave great attention to the development of petroleum and natural gas, treating the scientific and practical aspects of the Ohio fields with a thoroughness which I believe to be without parallel. At various times he studied and wrote upon the building stones, limestones, iron ores, rock water, gypsum and clays of Ohio and other States, elucidating the geologic relations and usually pointing out also their economic bearings.

From the mass of material thus accessible I select for special mention a single contribution to pure and applied science, choosing the one with which his name is most frequently associated by brethren of the hammer at home and abroad. I refer to his study of the relation of gas, oil and brine in subterranean reservoirs. It was well known that the flow of oil from a well is often preceded or accompanied by the escape of gas; it was known that the life of an oil well was often terminated by the influx of water, and that this water, when derived from the same reservoir as the oil, was highly charged with mineral matter; it was known that the static pressure of natural gas in a well was usually the same for all wells of a group or district, and independent of the altitude of the opening; and partial explanations of these facts had been suggested by various students; but it remained for Orton to formulate a comprehensive theory explaining all the phenomena, and then, testing it by comparison with a series of measurements and other observations in the gas and oil fields of northern Ohio and Indiana, to place it on a sure and enduring basis. Like many another result of elaborate and successful investigation, his theory, when stated, appears so simple as to be almost axiomatic, and one is tempted to wonder why the common sense not only of geologists but of all concerned in the development of petroleum and natural gas had previously failed of its attainment; and yet nearly every part of it has been at one time or other the subject of attack and controversy.

Each stratum of porous rock containing a profitable store of oil and gas is sealed above by some impervious layer, so that fluids cannot escape upward, though it may communicate freely with the surface of the ground at a distant point, if only the communication involves an inverted siphon equivalent to the plumber's trap. Under these conditions the stratum constitutes a reservoir in which three fluids arrange themselves according to gravity; gas occupies the pores of the upper part, and is succeeded downward by oil, which in turn rests upon water. If the stratum reaches the surface of the ground at a place lying higher than the reservoir, the water supplied to it by rains exerts a pressure, in accordance with the familiar hydrostatic law, on the water in the reservoir, and this is communicated to the oil and gas. The gas is compressed until its elasticity counterpoises the weight of the column of water. If, now, a well is drilled so as to tap the reservoir at its highest point, gas rushes forth, being forced out by the pressure of the water. If a well reaches the reservoir in the zone occupied by oil, the oil is similarly forced upward, and may be discharged at the surface in case the pressure from the water is sufficient. If a boring taps the reservoir still lower, it reaches water, which is similarly forced upward and may flow at the surface. The water is always a brine, because, occupying a closed reservoir, it has no circulation and has been dissolving for ages the soluble minerals contained in the rocks; and it is thus contrasted with the potable waters of artesian wells, which contain comparatively little mineral matter, because they are parts of an underground circulation and their sojourn within the rocks is comparatively brief. An ordinary artesian water does not rise in wells everywhere to the same height, the pressure, or head, diminishing as distance increases from the source of supply; but the stagnant brine underlying a body of petroleum is everywhere subject to the same pressure, and will rise to the same height in any well to which it has access. This principle is intimately related to the pressure under which gas escapes from a well and its knowledge has been found of great practical value to the natural gas industry.

It follows from the theory, and it is also a matter of observation, that as the gas in a reservoir is drawn off through wells, the underlying oil and brine rise to take its place, and when the local store of gas has been exhausted, the wells either produce oil or are flooded by brine.

With the demonstration of this theory the earlier idea, that gas was forced outward merely by its own elasticity, and that it was generated in subterranean laboratories from fossil organic matter as rapidly as it escaped, was completely disproved. It became evident that the supply of gas in each reservoir was definitely limited; that if once exhausted, it could never be restored; that economy was required in the use of natural gas, as with any other resource; and that the folly which permitted it to escape freely to the atmosphere was also a crime. That such criminal and disastrous folly was actually perpetrated in most of the gas fields of northern Ohio and central Indiana was not the fault of Dr. Orton, who early sounded the note of warning, and strenuously combated the infatuation of the well owners.

Of the high esteem in which Orton was held by his colleagues in scientific labor you are already aware. The Geological Society of America, an organization including the leading geologists of the continent, chose him as its president, to serve for the year 1897; the American Association for the Advancement of Science, foremost in importance among American scientific bodies, called him to the chair of its geologic section in 1885, and bestowed its highest office in the last year of his life. Even in his own country he was not without honor.

G. K. GILBERT.

ADDRESS OF THE PRESIDENT BEFORE THE AMERICAN SOCIETY OF NATURALISTS. *

BEARING in mind that we have with us this evening representatives of all branches of natural science, it seems better that I should not attempt to give here a sketch of the progress of botany nor discuss the special problems which botanists are trying to solve. Botany is certainly progressing, but progress is not hastened by stopping too frequently to consider just how much progress has been made. As far as questions of botanical research are concerned the past year has not been marked by any startling discovery, but it has been rather a year of transition, and the work done may be expected to bear mature fruit later. The most striking feature of the past year in our own country has been the publication of a remarkably large number of treatises of an educational character in which the results of recent botanical work have been presented in a fresh and attractive form, but this is evidently not an occasion on which

* New Haven, December 28, 1899.

one should speak of their merits or point out their defects.

Instead of calling your attention to any special phase of botany I shall take the liberty of presenting a few considerations suggested by a comparison of the different methods of organization of universities and other scientific establishments in this country and in Europe. Such considerations, although they apply to all advanced studies and research, whether literary or scientific, are not to be considered beyond our province, for in more ways than may at first be supposed there is a community of learning, and any method or organization which genuinely promotes one form of knowledge tends to promote the study of other branches. I say genuinely because I do not believe that a system which professes to encourage the exclusive study of one or a few subjects will in the end be successful.

Although any organization may be better than no organization at all, there is a possibility of pushing organization to an extreme, and, by putting too many wheels into our educational clocks, produce a disastrous amount of friction. Organization should be carried so far that the knowledge which has been acquired slowly and laboriously from experience and research is systematized in such a way that the student may be able to learn all that is possible without loss of time, and the investigator, well informed as to what is already known, be able to take up the thread of the unknown and unravel it to the greatest advantage. When organization goes so far as to dictate just who should do certain things and to prescribe stereotyped ways of work, it is always disastrous. Since a good organization of the forces at our command is probably the most efficient means of securing steady progress in science, an examination of different modes of organization should prove instructive.

Without entering into the futile question of the relative inherent capacities of the scientific men of different European nations, it is safe to say that we should all agree that, in point of scientific organization, the German universities surpass all others. Probably most of my hearers have, at some time, pursued their studies in Europe, and, if they have attended German universities rather than those of other countries, it was because they were convinced that, however eminent individual professors might be elsewhere, Germany was the place where the university system would enable them to obtain most readily the results of modern science and to prepare themselves for investigation. Although we Americans are supposed to have a sufficiently high opinion of our own abilities and our own institutions, it is certainly true that we are willing to learn from other nations. A considerable portion of the Americans who have studied in Germany have on their return home a feeling that the German university system is better than our own and desire to introduce German methods, and it is not necessary to remind you of the great influence which such a feeling has had on our own universities. Our social and intellectual conditions, however, do not permit us to transform our universities completely into institutions like German universities, and there has grown up with us a system which is peculiarly American, of which the full significance has in an important respect often been overlooked.

When one asks how our universities differ from those in Germany and other European countries, the answer generally given is that students who enter foreign universities have had a more thorough preliminary training than our own; that the instructors, taken as a whole, have a more profound knowledge of their specialties; and that the equipment in the form of libraries, laboratories and museums is more complete than in this country. Were these the only respects in which our own universities differ from those of Germany, for instance, we might believe that the differences would disappear in the near future. Our preparatory schools, it is claimed, are improving; our university instructors are becoming better equipped for their special work, and, at least as far as natural history is concerned, our libraries and laboratories are numerous and some of them are hardly inferior, for all practical purposes, to those of the best European universities. Were the differences I have mentioned the only ones, we could say with truth that there is no radical difference between our universities and those of Germany, but merely a difference in the comparative development, which time would obliterate. There is, however, another fundamental difference, on which it seems to me too little stress has been laid, a difference which, as far as I can see, tends to become more marked or which, at least, shows no signs of diminution in the near future. I refer to the method of university government. Strange to say, although we are living in a republic, the whole tendency in our colleges and universities is towards a more autocratic form, while in Germany, on the other hand, it is of a more democratic character. In other words, excluding the purely political question of supporting or, at least, of not interfering with the administrative measures of the government in power, the instructing, the learned body, the faculty, has in Germany more power in regard to appointments and the general policy of the university, while with us, the greater power lies with the president and the boards known variously as corporations, trustees and overseers. The German universities have no president, in our sense, but the presiding officer is selected annually from the body of professors in rotation. Nor is there in the English universities any officer corresponding to our college, or university, president, the chancellorship being rather an honorary position than one of active duties.

The American president, on the other hand, is a true executive of such importance and intrusted with such power that the selection of a proper president is a vital question. If he is capable, the college is successful; if he is incapable, it quickly falls behind. The successful modern president is, furthermore, a very different person from the president of twenty-five or more years ago. Formerly the president was frequently a professor selected for his eminence as a scholar, due regard being paid to his orthodoxy. His position as president did not debar him from continuing to lecture as a professor. The modern president is less frequently selected from the body of professors, and, if so selected, he is chosen not so much on account of his eminence in science or literature as from his presumed ability as an administrator. In becoming president he almost of necessity relinquishes his position as a lecturer. He must above all things be a man of good business head whose previous experience has given him a knowledge of educational methods. It is the president rather than the faculty who, in the opinion of the public, shapes the policy of the American university, for, although, accepting the suggestions of the faculty, he may adopt them as his own policy, he is not under the necessity of doing so, and the skillful president is usually successful in inducing the faculty to recommend the policy which he thinks advisable.

The preponderating influence of the president and financial board as compared with that of the faculty or board of instructors seems to me to be the most striking feature in our American system as compared with the European university system. The system has gradually developed with us from the time when one person combined the functions of professor and presiding officer. During the last 15 or 20 years the relative importance of the president has been more marked, owing to the fact that by the transformation of the older colleges into universities the amount of administrative work has been greatly increased, and with it has come the increasing necessity of depending more and more on the intelligence and activity of a single mind as supervisor and administrator. Furthermore, the remarkable increase in the number of colleges and universities, none of them with sufficient endowment to provide the elaborate equipment and large body of instructors required in a modern university, has brought about a competition between different institutions, each struggling to outdo the others, so that the college president has been forced to become a 'hustler,' to borrow an expression from the business world, and he is obliged to see that his own institution is not outdone by others in the scramble for private and public money to carry on establishments requiring additional sums for proper endowment. Whether we like it or not, I think it will be admitted that what I have described as peculiarly the American system of university organization is one which we must accept as unavoidable in this country, and there is no probability that the system will be changed essentially in a short time. That being the case, it is our duty to adapt ourselves to it and make the best possible use of it, not expecting that we shall be able to copy closely the systems of other countries except in certain details, which, however, are important.

The great charm of the German university hitherto has been what has been described as the intellectual atmosphere, the prevailing desire of pursuing learning and investigation for their own sake, which, however, does not unfit the Germans for the successful application of science in industrial and practical fields. We miss in our own universities this universal desire for investigation, which is with us confined to a certain number of persons who are very enthusiastic, to be sure, but are in most cases obliged to justify themselves in the eyes of those who do not understand the value of investigation.

Fashion and the natural tendency to imitate others has, however, done very much for us in recent years in aid of investigation, for, while it may be next to impossible to induce the governing board of a university to spend money on investigation for its own sake, it is a comparatively easy matter to convince them that they must make provision for original work because some other institution has done so and is thereby attracting public attention. If original research can be used as a means for advertising a university, there is no doubt that it will be encouraged, and, fortunately, as it turns out, it is a very good advertisement, even better than victories in athletics. The really successful American universities are those in which the most original work is done. The trouble is that if one looks upon research mainly as an advertising medium, one is apt to demand quantity rather than quality, and to regard the number of papers published annually as the standard of scientific activity.

The pursuit of science for its own sake which characterizes the German universities is one of the results of their form of organization. The faculty, the learned body, shape their own policy more than is the case with us, and they recognize the intrinsic value of research. With us it is necessary, through the president, to convince the corporation and trustees of its value before much can be done, and they, being for the greater part business men or professional men, rather than scholars, are apt to consider that research is valuable only in so far as it is what they call practical. In this view they undoubtedly represent the American public, and it is from the public that the money must be obtained for carrying on research, either directly from private individuals in the case of endowed universities, or indirectly through the legislatures as representing the public in the case of the State universities. The misfortune is that the word practical means nothing in particular, for even abstract science sooner or later has a practical application, and it often happens that what is supposed to be very practical is merely empiricism which a thorough theoretical study would show to be false.

It would be unjust not to admit that there is something to be said on the side of governing boards in the attitude which they take towards research. Research is expensive, and when the professors ask that it be encouraged that means something more than sympathetic words. It means money or relief from an excessive amount of teaching, which is the same thing as money, for some one must be paid to do the teaching. It can hardly be supposed that the governing boards are really opposed to research, although they at times overrate the value of formal instruction as compared with research. They feel that they have no money to spend, which is, unfortunately, often true, and, on the other hand, they do not understand the absorbing nature of research and the necessity for giving one's close attention to it. So long as research is subordinated to other work it cannot accomplish the best results, and any occupation, whether it be excessive routine work in the way of lectures or laboratory instruction, or whether it be the enforced necessity of going about and talking to private individuals or members of legislatures for the purpose of obtaining money for a proper equipment, stands in the way of, if it does not entirely check, research. In Germany the professors are able to pursue their original work without feeling that one of their functions is the raising of money for carrying on the work. Unfortunately, in most of our scientific establishments, in speaking of the professors, the double-headed question is not unfrequently asked: What work are they doing and how much money have they raised for the support of their laboratories? For the credit of American science, it is to be hoped that this question will soon be reduced to the simple inquiry as to the work done.

Hitherto I have spoken of American colleges and universities somewhat indiscriminately, since it is not possible to distinguish between them, some colleges not differing essentially from universities, while some so-called universities are not universities in any sense. By whatever name they are called my remarks apply to institutions in which advanced instruction is given, looking ultimately to original research by specially qualified students and by the instructors, and in the same class should be included the better scientific schools, for, although it is hardly proper strictly to compare their organization with that of a German university, many of the anomalous conditions found in our universities and colleges are found also in our scientific schools. I have assumed that all such institutions have the double function of teaching and investigation, a dogmatic view perhaps, but one with which I presume most, if not all, of those present this evening are in sympathy, although there are people, especially some who think that they are very practical, who hold a different opinion.

We believe that the two functions must be combined in a university because we know from experience that, in the cases where instruction is considered to be the sole function, stagnation, not progress, is the result. On the other hand, if research were the sole function of a university, it would be difficult to see where else those desiring to become investigators could be properly trained. The real question is as to the amount of instruction.

It has been the custom in comparing our universities with those of Germany to lament the absence of uniform standards of admission requirements and of qualifications for higher degrees in this country. If by that is meant that it is to be regretted that our standards are not higher, the lamentation is justified. But if, as some think, what we need is a uniform standard in these respects, to be enforced by agreement of the different universities or initiated by the establishment of a national university, I, for one, am thankful that we have no such uniformity. The present uniformity in Germany is the result of an old civilization, and the prevalence of similar educational and intellectual conditions for many years. In the course of time our educational conditions will become more and more uniform and we may have, perhaps, uniform standards of admission and graduation, but, if so, they will be the results of a natural development, not of prescription. So long as the social and political conditions of the different parts of our country differ as they do, real uniformity in university standards is out of the question. Even in sections of limited area the attempts at enforcing uniformity among the different colleges have at times shown the ease with which rules can be kept in theory and yet broken in practice.

The possibility of establishing a genuine national university superior to all others in equipment and authority seems to most of those interested in educational matters to be remote, but, were it possible to have such a university, one could hardly imagine a greater misfortune to learning in America. One need only glance at the condition of things in Germany and France to recognize the benumbing effect of concentrating in one place, especially if it be the political capital, the greater portion of the scientific establishments. The wide-spread intellectual activity of Germany is, I think, mainly due to the existence in times past of many scattered universities, some better than others, no one, however, superior to all the rest, but all centers of learning, generous rivals in the promotion of knowledge. Whether under imperial Germany the concentration of resources on fewer universities, with a tendency to still greater concentration hereafter, may not have an unfavorable effect on the nation in the long run, is a question which the future must answer. That the concentration of scientific work and workers in Paris has had an injurious effect on France is evident to the French themselves, and they have in recent years made efforts to strengthen the universities in other parts of France. Our country is so large and so varied in population and occupation that we need many independent centers of learning and numerous universities, zealous in promoting knowledge, but not subordinated to a national university, either directly or indirectly, by the expenditure of national funds on a single institution. Whether such universities should be privately endowed or supported by the States is a question to be settled in each case by the locality and tradition.

If it is true that the promotion of science and learning in a country like ours is best accomplished by the existence of numerous independent universities, there is still a large field of research on which government funds may be legitimately spent. The principle that what can be well done by privately endowed universities, or by those supported by the States, had better be left to them rather than be undertaken by the national government, seems to me to be a sound one and to be in accord with the spirit in which our government was founded. Centralization in science, as in government, may be necessary at times, but is to be avoided when possible. There must, however, always be questions affecting the national welfare which it is undoubtedly the function of the general government to investigate. The study of contagious diseases of man and animals, involving as it does questions of quarantine and other sanitary regulations, which may affect any or all the States, and the study of plant diseases, however caused, and the means of prevention, are good instances of the kind of work which should be undertaken by the national government, for they are of such eminently practical nature and so general in their application that it is important that the government should have constantly in its service experts capable of studying them and of giving at short notice information that may be needed. The theoretical aspects of the subjects mentioned and the study of certain special cases may profitably be undertaken by private or State institutions, but the resources and authority of the general government are needed for the obtaining and spreading of information and the enforcement of preventive or remedial measures. It is an important duty of our universities and scientific schools to train up a body of young men capable of entering the different governmental bureaus as scientific experts, that is to say in the lower grades, for it is not supposed that without a more or less lengthy active service in the bureaus themselves one would be prepared to fill the higher positions. In Germany there seems to be no difficulty in finding among the graduates of universities and technical schools well-trained young men for the scientific establishments of the government. If things are not in so satisfactory a state here it is due, in part, to the very rapid enlargement of the scope of government work in recent years, and there is no reason to suppose that before long the supply of well-trained young men will not equal the demand.

In my remarks this evening I have felt free to state what, to the best of my knowledge, seems to be the condition of our scientific organization, especially in our universities; but in what I have said I have endeavored merely to describe the situation viewed generally, and, if I have taken this occasion to refer to some points in which our system might be improved, I have done so without reference, either expressed or implied, to any institution or locality, but because I cannot help feeling that a plain statement of certain difficulties from which many, if not most of us, suffer is the first step to be taken if we are to expect improvement. I have described the older German universities as generous rivals in the promotion of knowledge. From conditions beyond our control we are at present in a condition of unrest and feverish ambition, each university striving, on insufficient means, to do all that any other university is doing. When shall we become cool-headed enough to do well and thoroughly what our means permit, and wait patiently for the time when we can expand farther without too great tension or attenuation of the resources now at our command?

W. G. FARLOW.
HARVARD UNIVERSITY.

INHIBITING ACTION OF OXIDASE UPON DIASTASE.

IN the disease of the tobacco leaf known as Calico, or Mosaic, the lighter-colored areas are found to contain more starch in the form of granules than do the green areas of the same leaf. This is very peculiar, inasmuch as the chloroplasts of the light-colored areas are evidently in an unhealthy condition.

In an article published in the *Centralblatt für Bakteriologie*, II Abt. Bd. V., No. 22, I have pointed out the fact that these light-colored cells exhibit much more oxidizing activity than do the green cells of the same leaf. The light-colored areas were found to correspond with the light-colored patches produced by insect punctures, certain fungi, and especially in that group of diseases known as variegation or albinism.

All these cases show a greater amount of oxidizing enzymes (oxidases as well as peroxidases) in the light-colored tissues. Mainly upon this evidence I was obliged in the article mentioned to differ from most other writers on the disease in question, in calling the lighter-colored tissues diseased, and the deep green patches, especially along the veins, healthy. It is true that much tobacco is apparently normally as light colored as the light-colored areas in the diseased leaf, but, on the other hand, there is quite as much which is normally as green all over as the green areas in many of the diseased leaves. It is true that some of the green patches, especially where the light-colored areas are unusually light, are abnormally green. A study of the histology of the diseased leaves has now revealed a histological difference which makes it very clear that the light-colored areas are not normal, and this difference consists in the fact that in badly diseased plants the palisade parenchyma of the light-colored areas is not developed at all. All the tissue between the upper and the lower epidermis consists of a spongy or respiratory parenchyma rather more closely packed than normal. In moderately diseased plants the palisade parenchyma of the light area is greatly modified. Normally the palisade parenchyma cells of a healthy plant are from four to six times as long as broad. In a moderately diseased plant, however, the cells are nearly as broad as they are long, or at most not more than twice as long as broad. As a rule, the modified cells of the leaf pass abruptly into the normal cells of the green area. In a badly diseased leaf simply looking across the surface with the naked eye shows depressions where the light areas occur, or where the leaf is mostly diseased the dark green patches are raised above the general surface.

The cells of the diseased area also translocate their starch with difficulty, the cells often becoming completely gorged with this material. The examination of the diseased spots early in the morning shows only a small decrease in the starch content of the cells from that present the previous afternoon, while the green, healthy tissues either contain no starch or contain only traces of it. It was thought that possibly the increase of oxidizing enzyme might either inhibit the production of diastase by the cell or inhibit the action of diastase upon starch. In order to settle this point strong solutions of tobacco oxidase were prepared, and after heating some of the solution to the boiling point, thus killing the oxidase, comparisons were made by adding 10 milligrams of taka diastase in solution to each of the tubes of juice to be tested. Equal quantities of freshly prepared potato starch paste were then added to each tube and the tubes kept at 45 degrees Cent. It was found that in the solution without oxidase the starch was completely converted into sugar in thirty minutes, while the solutions in which the oxidase was active only carried the change of the starch to the erythrodextrin stage. The action of the diastase of malt added in solution in the same quantity was somewhat less rapid than that of taka diastase, but the relative effects were exactly the same : the presence of the oxidase in the solution had a marked inhibitory action upon the activity of the diastase.

In these tests the proportion of diastase to oxidase was much greater than occurs even in the diseased cells, so it is likely that the inhibitory action of the oxidase in the cells is much greater than that shown in the tests outside of the cells.

It would seem a warrantable conclusion, therefore, that the tardiness in the translocation of starch in the diseased area is to be explained by the abnormal activity of the oxidizing enzymes of these cells, and that the mode of this action is by retarding or weakening the activity of the translocation diastase. This would also help to explain the slower growth of the diseased cells.

Albert F. Woods.

Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture.

*THE MEXICAN HALL OF THE AMERICAN MUSEUM OF NATURAL HISTORY.**

When the Europeans first set foot in Mexico, they were met by a numerous people who had become settled into nations, and had developed a civilization which was astounding and incomprehensible to the conquering adventurers. The antiquity of this American civilization was so great, and it was so widely spread over Mexico and Central America, that there still remains a vast accumulation of materials exemplifying the daily life of the people. Hundreds of temples and other large and elaborate structures and sculptures in stone, which were connected with the ceremonials of an all-pervading religion fostered and maintained by priests and rulers, stand as monuments of this ancient civilization.

Several distinct phases of this culture resulted from modifications by different tribes with distinct languages and customs. In Mexico proper the most powerful nation was that of the Nahuas, commonly known as the Aztecs. Their principal seat was in the Valley of Mexico, but by migrations and conquests they left their imprint in various parts of Mexico and Central America. The other prominent cultures of this ancient time in Mexico are attributed to the Tarascans in the States of Michoacan and Jalisco, the Zapotecans and the Mixtecans in the State of Oaxaca, and the Totonacans in the State of Vera Cruz. The great southern development, in many ways the highest phase of this American civilization, is attributed to the Mayas. It extended from the State of Chiapas on the north, through Yucatan and Guatemala, to northern Honduras, where in the Copan Valley it probably reached its highest development.

From the time of the conquest by Cortes this ancient civilization on the American Continent has been a wonder and a mystery. Some of the Spanish priests and native writers following the conquest left accounts of the people and their customs, from which the student of to-day is obtaining important information; but it is only during the present century that serious research has been directed to the study of this remarkable phase of American archæology. The publication, by Stephens in 1841, of the volumes containing illustrations by Catherwood of the ruins in Chiapas, Yucatan and Central America, first aroused attention among English-speaking peoples to the ruins of these ancient cities of America with their strange sculptures. From that time this interest has been increasing, and during the last decade systematic exploration and research have led to many important discoveries, the beginnings of definite knowledge concerning the origin and development of this past American civilization.

It was in furtherance of this research that the American Museum secured from the Government of Mexico the right to explore the ancient ruins in that country. It was for this object that Mr. Lorillard provided the means for Charnay's expedition to Yucatan and other parts of Mexico. It was this incentive that led Mr. Thompson to take up his abode in Yucatan, and that induced Dr. and Mrs. Le Plongeon to pass years of arduous labor in that country. For this purpose the Duke of Loubat sent

* Opened on December 12, 1899.

Dr. Seler on a special expedition to Mexico and Central America; and to this end Mr. Maudslay, of England, has devoted much of his time and private means. For the same purpose Messrs. Bowditch, Salisbury and others have for several years given their generous support to the Peabody Museum of Harvard University, that explorations might be carried on in Yucatan, Guatemala and Honduras.

All this research has made it possible to secure such an exhibit as is now installed in the Mexican Hall of the American Museum of Natural History; but it is due to the intelligent interest and liberality of the Duke of Loubat that the Museum has been able to bring together this large and important collection, which is soon to be exhibited for the instruction of the public.

The originals of the great sculptures in stone, of which facsimile casts are here presented, are, with the exception of a few specimens in other museums, still buried in tropical jungles or amid the ruins of ancient temples. The general labels on each of the larger specimens, and the illustrated labels in the frames near them, give information relating to each of these sculptures (known as monoliths, stelæ, idols and altars) from the prehistoric ruins of Quirigua in Guatemala and of Copan in Honduras. These are all monuments of the Maya culture, and on most of them will be seen groups or columns of hieroglyphs, the deciphering of which is one of the most important researches in American archæology. The sculptures at the farther part of the hall are from Mexico, and belong mostly to the Nahuatl culture. The dark color of the casts shows that the originals are of a different kind of stone from that used in Quirigua and Copan.

On entering the hall, the most conspicuous object on the left is the so-called 'Great Turtle of Quirigua.' To the right is a large 'idol' known as the 'Dwarf,' because it is the smallest of the stelæ standing amid the ruins of Quirigua. A cast of the largest of these monoliths, standing twenty-five feet above ground, is too high for this hall. It is exhibited in the hall below, where from the gallery a study can be made of the upper portions of the sculptures.

On the right of the hall is a restoration of the sanctuary of the 'Temple of the Cross,' showing the position of the bas-relief known as the 'Tablet of the Cross,' with the officiating priests and the hieroglyphic inscription. In a frame on the side of this reconstruction is an illustrated label explanatory of this temple at Palenque. In the table-case near by are several pieces showing hieroglyphics and figures made in stucco, which was widely used. The great 'Calendar Stone,' the most remarkable of Mexican sculptures, is shown on the south wall. On the walls and screens on the north side of the hall are many fine bas-reliefs from ruins in Guatemala, Honduras, Palenque and Yucatan. Over the northern case at the east end of the hall is a group of slabs from Palenque, upon which are many columns of hieroglyphs. Over the adjoining case, and on the south wall near by, are casts of slabs from the ruins of Chichen Itza in Yucatan. Here are also the sculptured stone posts of a doorway upon which rests a carved wooden lintel. To the right of this is shown the sculptured wall of a portion of a room in a temple at Chichen Itza, on which are many human figures and a feathered serpent. There is evidence that this and many of the other sculptures were formerly painted in several colors, of which red, yellow and blue predominated. The statue of Chac-Mool, found by Dr. and Mrs. Le Plongeon at Chichen Itza, is an instance where the colors were still preserved. The cast of this reclining statue was colored by Mrs. Le Plongeon in exact copy of the original when found.

In case A are the Tarascan terra-cotta figures and stone sculptures secured by the Lumholtz expedition.

In case B, on the east end of the hall, are original sculptures in stone from Copan and Yucatan.

In case N is a collection, also from the Lumholtz expedition of pottery from the ruins of Casas Grandes, illustrating a culture approaching that of the ancient Pueblo people of Arizona and New Mexico.

In three other cases at this end of the hall, and several cases at the opposite end, are various collections, including jadeite ornaments, copper implements and ornaments, carved stone yokes, a large terra-cotta human figure, and pottery vessels of many forms, all illustrative of the culture of several of the ancient Mexican peoples.

Cases C and D contain the collections made by Dr. Seler in Mexico and Guatemala, and presented by the Duke of Loubat. In another case are terra-cotta figures of great value found over a tomb in a mound at Xoxo by Mr. Saville of the Museum expedition. A cast of the inscribed stone lintel of the door, and many vessels found with skeletons in this tomb, are most interesting objects.

The ancient Mexicans and Mayas had many manuscripts or codices consisting of picture-writing and of hieroglyphs. These were on prepared deer-skin or on native paper made of maguey fiber and coated with a kind of white cement. Several of these codices were sent to Europe soon after the Conquest, and others have since been found. They are of the utmost importance; but, being few in number and widely scattered, they were of little use until reproduced in facsimile, so that every student could have access to them for comparative study. In the two cases in the center of the hall, and in the frame over them, are a number of copies of these important records. For these the Museum is indebted to the Duke of Loubat, at whose personal expense several of these manuscripts have been reproduced in facsimile.

There is thus brought together in this Mexican Hall of the Museum the most important collection in existence for the study of the ancient civilization of Mexico and Central America.

F. W. PUTNAM.

HARVARD UNIVERSITY.

CORRESPONDENCE RELATING TO COLLECTIONS OF VERTEBRATE FOSSILS MADE BY THE LATE PROFESSOR O. C. MARSH.

THE following copies of letters have been sent to the Editor of SCIENCE by Hon. Charles D. Walcott, Director of the United States Geological Survey.

DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
WASHINGTON, D. C., May 5, 1891.

THE DIRECTOR,
U. S. GEOLOGICAL SURVEY,
WASHINGTON, D. C.

SIR:

* * * * * * *

The large collections of vertebrate remains in the charge of Professor O. C. Marsh, at New Haven, Connecticut, are kept in the fire-proof Peabody Museum building, and in a large storage shed adjoining. The method of recording is somewhat different from the other collections, but it is very thorough and complete.

In the field where the specimens are collected a label is placed inside of each box as it is packed. On this U. S. Geological Survey is printed in bold letters. On the outside of the box U. S. Geological Survey is plainly marked before the boxes are shipped. When received at Professor Marsh's laboratory in New Haven, a record is made of each box received and to each an entry number is assigned. This number is at once recorded on the box and, when the box is opened, on the label and on each and every specimen contained in the box with an oil paint. When it is necessary to remove a number in working out specimens from the matrix, the number is copied on some other portion of the rock or directly on the fossil before it is removed from the other portion. This number is the record of locality, stratigraphic position, and history of discovery; additional information is added from time to time under the number in the record book. This includes the identification of the genus and species and any data that may be of importance. The removing of the number from any specimen at once deprives it largely of scientific value, and it is to the interest of every one working on the collection to have it kept intact. When the final work is done and the specimen is identified, labeled with its name and ready for exhibition, it then receives a catalogue number. The old number, however, still follows it in the record of the latter.

The record of the entry number is kept in duplicate and Professor Marsh is now preparing another duplicate set to be filed with the Geological Survey. This record will show the number of boxes of specimens received, from 1882 to 1891. The laboratories and storage rooms provided by the Yale University Museum represent a floor space of over 9000 square feet, for which the Geological Survey does not pay rent. In addition to the collection at New Haven, there are seventy boxes of vertebrate fossils stored in the Armory building in Washington, and a collection is now being prepared for exhibition in the United States National Museum.

* * * * * * *

Respectfully yours,

(Signed) Chas. D. Walcott,
Paleontologist.

Department of the Interior,
United States Geological Survey,

December 8, 1899.

Professor S. P. Langley,
Secretary, Smithsonian Institution,
Washington, D. C.

Dear Sir: I have the honor to state that all the vertebrate collections of the late Professor O. C. Marsh, belonging to the Government, have been shipped from New Haven, Conn., and are now transferred to the custody of the U. S. National Museum, subject only to the use of such material as may be necessary for study and illustration in the completion of the monographs that were in course of preparation by Professor Marsh at the time of his death.

From a statement submitted by Mr. F. A. Lucas, who had charge of the packing of the collections, it appears that there were 1200 trays (20–26 inches) of specimens, 200 unopened boxes as received from the field, 30 blocks and 90 prepared specimens. To ship this material required 592 boxes, forming five car loads, having an aggregate weight of 160,000 pounds. To this there should be added two car loads containing 211 boxes received from Professor Marsh on deposit in 1891 and 1898.

The actual number of specimens represented in this collection cannot be stated. They range in size from minute teeth of fossil mammals to individual specimens weighing from 500 to 2000 pounds each. The collections are rich in large Dinosauria, especially in examples of *Triceratops* and *Stegosaurus*, while the series of Titanotherium skulls is one of the best, if not the best, in existence. It contains 50 or more complete examples cleaned, and a number in the rough, besides many hundred bones.

Among the specimens transferred are the types of 40 or more species, including Dinosaurs and Jurassic, Cretaceous and Tertiary mammals. Among the types are the following:

DINOSAURS.	JURASSIC MAMMALS.
Diplodocus longus.	*Paurodon valens.*
Labrosaurus ferox.	*Manacodon rarus.*
Camptosaurus nanus.	*Enneodon crassus.*
Triceratops sulcatus.	*Enneodon affinis.*
Triecratops californis.	*Laodon venustus.*
Triceratops obtusa.	CRETACEOUS MAMMALS.
Pleorocœlus nanus.	*Priconodon crassus.*
Ceratosaurus nasicornis.	*Cimolodon agilis.*
Ceratops montanus.	*Telacodon præstans.*
Ceratops alticornis.	*Oracodon cenulus.*
CROCODILES.	*Allacodon pumilis.*
Rhytidodon rostratus.	*Batodon tenuis.*
SNAKES.	*Allacodon fortis.*
Coniophis precedens.	

I requested Mr. Lucas to make an appraisement of the value of the specimens. He states that this is a very difficult thing to do, but that many of the specimens could not be replaced, and some specimens, like the skulls of the *Triceratops*, should be worth at least $5,000 each, while crania of *Titanotherium* are worth from $50 to $250 each, according to perfection, and that an estimate of the value of the entire collection will be upwards of $150,000. This is, of course, tentative, as some of the material has not been worked out at all, and some not removed from the boxes in which it was shipped from the field.

It is to be recalled that these collections were made by Professor Marsh during his connection with the Geological Survey, from 1882 to 1892 inclusive; that prior to his connection with the Survey he made large collections, including the toothed birds, the *Dinocerata*, *Brontosaurus*, many Dinosaurs, and the best *Titanotherium* yet discovered. He also purchased numerous collections after the stopping of allotments for his work in 1892. These collections were transferred to Yale University some time prior to his death.

As there has been considerable comment in relation to this matter, I send you a copy of a report on the examination of the collections under Professor Marsh's charge, made by me to the Director of the Geological Survey, in 1892.

I twice visited New Haven while the collections were being packed, and am fully convinced that all material belonging to the Government has been transferred to Washington. Mr. Lucas reports that the Trustees of the Peabody Museum in New Haven gave him every facility for packing the collections, and that the records were so complete that no difficulties arose in determining those specimens which belonged to the Government and those which were the property of the Peabody Museum.

The transfer of these great collections to Washington without the loss of any material, either through imperfect recording or through misunderstanding as to the ownership of specimens, reflects the greatest credit on the business-like methods and the integrity of Professor Marsh. The addition of the material to the National Museum places it in the front rank among museums in its collection of vertebrate fossils. It is necessary that some gaps in the collections be filled, and I sincerely trust it will be possible for the Museum to do this at an early date.

Yours respectfully,

(Signed) CHAS. D. WALCOTT,
Director.

INCLOSURE.

SMITHSONIAN INSTITUTION,
December 22, 1899.

DEAR SIR: I take great pleasure in acknowledging the receipt of your letter of the eighth instant, advising me that you have transferred to the National Museum all the vertebrate fossils collected by the late Professor O. C. Marsh belonging to the United States Government, subject only to the condition that such material as is required may be used for study and illustration in completing the monographs which were in preparation by Professor Marsh at the time of his death.

The addition of this immense collection of most important American fossil remains to the treasures already assembled in the National Museum will, I am sure, afford the greatest satisfaction to all workers in the field of paleontology both at home and abroad, and you will permit me to add a personal word in appreciation of your untiring efforts to facilitate in every way possible the great task connected with the removal of the collection from New Haven to Washington.

During the coming year I expect to have two preparators engaged in working out of the matrix specimens still uncleaned, and confidently hope that it may be possible in a few years to have the entire collection made available for study and a selected series for public exhibition. From this latter series the public will be able to form a correct idea as to the number, variety and great size of these wonderful extinct creatures of the western country, and will undoubtedly be impressed with the extent and importance of the work of the paleontological divisions of the Geological Survey and the marvelous industry and intelligence displayed by Professor Marsh in bringing together this great collection.

Yours respectfully,

(Signed) S. P. Langley,

Secretary.

The Honorable Charles D. Walcott,
Director United States Geological Survey,
Washington, D. C.

SCIENTIFIC BOOKS.

On the Building and Ornamental Stones of Wisconsin. By E. R. Buckley, Ph.D. Bull. No. IV. Economic Series No. 2. Wisconsin Geological and Natural History Survey. 1898.

The first attempt at a systematic investigation of the building stones of the United States was undertaken by Dr. G. W. Hawes under the auspices of the 10th Census. With the untimely death of Dr. Hawes the completion of the work fell into the hands of others, none of whom were experienced and some of whom had received no training such as should fit them for special investigations of this nature. Under such conditions it is not strange that the printed volume* should have been somewhat disappointing. Nevertheless it furnished a beginning and at least served to show what was not known on the subject.

This was followed in 1887 by Merrill's Handbook of the Collections of Building and Ornamental Stones in the United States National Museum,† which was based upon the Census Collections; and later by Stones for Building and Decoration (Wiley & Sons, New York), the first edition of which appeared in 1891 and the last in 1897. The above constitute the only comprehensive systematic treatises compiled with reference to the United States that have thus far appeared.

Several excellent special and local reports have, however, been made, among which should be mentioned Winchell's report on the building stone of Minnesota,‡ and the reports of Smock on those of New York; § Williams on the Syenites of Arkansas; || Hopkins on the Marbles of Arkansas, ¶ the Brownstones of Pennsylvania, ** and the Carboniferous Sandstones of Western Indiana; †† Macallie on the Marbles of Georgia; ‡‡ H. F. Bain on the

* Special Report on Petroleum, Coke and Building Stone, Vol. X., Rept. 10th Census, 1884.

† Rep. U. S. National Museum, 1886, pp. 275–648.

‡ Vol. I., Final Report on the Geology and Natural History of Minnesota, 1884, pp. 142–194.

§ Bulls. No. 3, New York State Museum, 1888, and Vol. III., No. 10, 1890.

|| Ann. Rep. Geological Survey of Arkansas, 1890, Vol. II.

¶ Ann. Rep. Geological Survey of Arkansas, Vol. IV., 1890 (1893).

** The Building Materials of Pennsylvania, I. Brownstones, Appendix to Ann. Rep. of the Penna. State College for 1896, pp. 122.

†† 20 Ann. Rep. Dept. of Geology and Natural Resources of Indiana, 1896, pp. 186–325.

‡‡ Bull. No. 1, of the Geol. Survey of Georgia, 90 pp. 1894.

Stones of Iowa;* and lastly that of Mathews and Merrill on those of Maryland.†

The volume noted at the head of this article, bearing the date 1898 but seemingly not issued till the latter part of 1899, is the latest and most pretentious of them all, with the exception of that of the 10th Census, comprising some 566 pages with 49 full-page plates and four figures in the text. The plates include a colored geological map of the State and seven others in which the natural colors and textures of the stone are approximately reproduced by lithographic processes, the remainder being half-tone reproductions of quarry views and stone structures. The work is divided into three parts: (1) Demand, Uses and Properties of Building and Ornamental Stones; (2) Geological History of Wisconsin and Description of Areas and Quarries, and (3) Appendix, On The Composition and Kind of Stones.

The chief interest and value of the work center in part II. (pp. 75–357 inclusive), since the only information heretofore available on these points has been that given in the 10th Census report above referred to, and Merrill's Stones for Building and Decoration. The work has apparently been well and thoroughly done. By far the most interesting stones described, and the ones which on account of color may hope to find a market beyond the State limits, are the Montello, Waupaca, Waushara and Wausau granites, and the Berlin rhyolites. The brown sandstones of the Lake Superior region should, in the Middle and Western States, fill the place of the red brown Triassic stones in the Eastern. In nearly every instance samples of the stone described have been submitted to laboratory tests and their crushing strength, absorptive and general weathering properties ascertained, so far as is possible by these methods. It is a trifle discouraging to note that it was considered necessary to go to the expense and trouble of making over 100 tests of crushing strength on rocks which even a casual inspection would have shown to be sufficiently strong for all practical purposes. Concerning the value of such tests the present writer has expressed himself elsewhere.

* 8th Ann. Rep. Geol. Survey of Iowa, 1898.

† Vol. II., Rep. State Geol. Survey, 1899, pp. 241.

If one were disposed to be critical he might call attention to the carelessness manifested in some of the very few references given, and to the tendency to ignore the work of others, Professor A. D. Conover's paper of fifteen quarto pages in the report of the 10th Census, not even being mentioned. There is, further, a non-convincing air of freshness in the explanation put forward on p. 383, to account for the unfavorable action of freezing temperatures on newly quarried material.

Colored illustrations add to the attractiveness of the book, but are to some extent misleading, giving a perfection of surface and brightness of color, which the materials themselves do not possess. This is particularly the case with the red and pink granites. Plate 34 of the Lake Superior sandstone is also disappointing, as, indeed, is plate 45 of a similar subject in the 10th Census report, and plate 27 in that of the Maryland Survey. The attempt is instructive, as showing the relative merits of lithographic reproductions from colored drawings, as compared with the tricolor photographic process used in the Maryland report, the advantage however, being wholly with the latter.

Very poor taste has been shown in the arrangement of the views of quarries and structures in the half-tone plates, and particularly those numbered 4, 17, 24, 42 and 47. A picture which does not illustrate some definite feature is out of place in a work of this nature, and, if of value, it should be so oriented on the page as to be easy of reference. The fad for placing the several views on one page at varying angles with one another is not readily excusable, and in this particular case the effect is very inartistic as well.

There is much to be commended in the work, but it is not too much to say that it would be more useful if of half the size. The amount of paper involved is out of all proportion to the information contained therein.

GEORGE P. MERRILL.

Untersuchungen über die Vermehrung der Laubmoose durch Brutorgane und Stecklinge. By DR. CARL CORRENS, a. ö. Professor der Botanik in Tübingen. Jena, Gustav Fischer. 1899. Pp. xxiv + 472. 187 figs. Price, 15 M.

This extensive and very detailed work brings together a large number of observations on the vegetative reproduction of the true mosses by means of cuttings and of gemmæ, by which are meant those structures which serve, like the spores, to disseminate the plant over more or less extended distances. Interesting matters of biological interest are suggested to the mind by the analogies existing between these organs and seeds, but these will be referred to later on in the review.

The text is divided into two parts. A first or special part consists of a descriptive treatment of gemmæ and cuttings and of their behavior, arranged along taxonomic lines. The general part which follows treats of the morphological and anatomical structure of the organs under consideration, of their germination and of the conditions necessary for their occurrence and growth.

The large number of observations brought together in the special part prevent any adequate presentation in the limits of a review, so that it is possible only to point out that the great variety of asexual reproductive bodies which are found in the mosses may be reduced to a few types, viz.: the stem, leaf and protonema types. The stem type is found in those plants in which the stem is transversely breakable at intervals throughout its length, or merely at its base or apex. In this type the leaves may be reduced, resulting in bulbil formation, or the stem, to form brood-buds.

The leaf type occurs in forms in which the leaf is broken off as a whole and germinates, or is separable into fragments, each acting similarly.

True brood-bodies, so called by the author, arise only from the protonema in the wide sense, including that produced from the stem (rhizoids) and the chloronema.

The facts in this part which will interest especially, perhaps, the general botanist, are those relating to the methods by which these brood-organs are separated from the parent plant. This separation is accomplished either by the tearing of certains cells (rhexolytic) or by a splitting apart of cells by the behavior of the inner lamella (schizolytic). The rhexolytic process may be provided for by a special zone of cells or by a single cell, according to the complexity of the structure. The cell appointed for the sacrifice is called by Professor Correns a 'tmema' a term which constitutes a very picturesque addition to botanical terminology, the more so when one contemplates its compounds 'dolichotmema,' 'brachytmema' and the hybrid 'strecktmema.'

In the special part are first discussed the morphology and phylogeny of the brood-organs. Here the author advances the notion that the aërial part of the moss plant (*i. e.*, the stem and leaf) is phylogenetically older than the protonema and that it results from a reduction of the moss stem, though not, says the author, in the sense of Sachs and others, according to whom the oblique position of the transverse walls of the protonema is an indication that its terminal cell is the homologue of the apical cell of the moss stem, an explanation which, it will be conceded quite generally, is forced. According to the author's view, the forms such as *Ephemerum* and *Buxbaumia* are reduced and not primitive as to their shoot characters. This statement is probably correct in itself with regard to *Buxbaumia*, high authority to the contrary notwithstanding; though it is difficult to see why this fact may not very naturally and easily harmonize with the opinion of Goebel by supposing that a secondary reduction, correlated perhaps with the more pronounced development of the sporogonium, has taken place. This position is strengthened by the indubitable fact that analogous reduction has taken place in the sporophyte of some of the Spermatophyta.

Following is a discussion of the structure and development of brood-organs. A circle of interest centers in the paragraph in which it is pointed out that the nematogonal cells (the initial cells which give rise to protonemal structures) preserve their embryonic peculiarities, and regards this as an especially good example of the 'continuity of the germ plasm.'

The special adaptations for the abscission of brood-organs have already been referred to. It may be added that active loosening of the brood-bodies is of very restricted occurrence. In the vast majority of cases the breaking away is passive, depending on the impact of air, water and animals. The same end is held by some observers to be attained through water absorption or drying out, and purely hygroscopic movements. Dissemination may occur by means of air and water currents, and a quite well established case is recorded in which Thysanura were responsible for carrying the brood-bodies of Aulocomnium and Androgynum. The projection of the parts bearing brood-organs above the general levels of the moss-turf is interpreted as an adaptation for dissemination through such animal forms. Hook-like organs occur (*Ephemeropsis* and *Bryum bulbilosum*), which are subject to similar teleological interpretation, though one with difficulty escapes the conviction that the point is somewhat far-fetched. Mucilaginous outer membranes, which insure adhesion to animal forms, are also present in some kinds.

Of the remaining matters perhaps the most important to mention here are the attempt to determine whether correlation occurs between the habit of producing gemmæ and the conditions under which the plants live, and to estimate the taxonomic value of the organs in question.

The typography and numerous illustrations are up to a high standard, but do no more than justice to the thorough work of the author. A full index of generic and specific names extends greatly the usefulness of the volume, which will be of very great value to those botanists who are interested in the biological matters relating to the mosses, but whose studies have not been directed to them in a taxonomic way. It will also serve a good purpose in enabling the student who may be contemplating research in these lines to orientate himself historically. This will be facilitated also by a very complete bibliography.

FRANCIS E. LLOYD.

FROM a systematic standpoint this work is of great value to American students, for of the 110 species described, 52 are known to occur in this country, and 108 out of the 187 figures refer to them. Systematic books have overlooked asexual methods of reproduction except in such cases as *Georgia pellucida*, *Aulacomnion palustre*, *Tortula papillosa*, and a few others where the means were so conspicuous as to defy ignorance; hence it will be a surprise to learn that *Dicranum scoparium*, *Funaria hygrometrica*, *Bryum argenteum* and *Dicranella heteromalla*, though commonly found fruiting, have also methods of propagation. Those species which are conspicuous for their brittle leaves are many of them rare in fruit, forming new plants from the fragments of the leaves, but an interesting addition to the list having this method is *Anomodon tristis*, which thus far is unknown in fruit. The 'Confervæ Orthotrichæ,' those brown septate bodies which occur on the leaves of various species of *Orthotrichum* and *Grimmia*, have long been familiar, but few students have realized why so many species of *Campylopus*, *Tortula*, *Bryum* and *Plagiothecium* were more often found sterile than fertile, nor how they reproduced in spite of this fact. Climates where sexual reproduction is difficult cause a greater development of other methods, and dioicous species are more apt to develop asexual methods than monoicous ones. An artificial key is given by which the asexually propagative species may be classified according to the modifications of the stem, leaves and protonema; it will be useful in encouraging the study and collection of such species as have been ignored or overlooked on account of lack of fruit. The work has paralleled that of F. De Forest Heald, published in the *Botanical Gazette* for 1898, but it is more extensive, and the author claims to have found that *Bryum annotinum*, *Pleuridium nitidum bulbillifera* and *Leptobryum pyriforme* are identical. There is a similar identity between *Pottia riparia* Austin, which antedates *Leptodontium Canadense* Kindb. and *Trichostomum Warnstorfii* Limpr., all of which propagate by clusters of septate propagulæ borne on the paraphyses, seemingly replacing the archegonia, hence all but *Pottia riparia* have thus far been only found sterile. Under whatever genus the species is recognized, that of Austin has priority, a fact to which I have already called attention.

E. G. BRITTON.

N. Y. BOTANICAL GARDENS,
BRONX PARK.

The Physical Nature of the Child and how to Study it. By STUART H. ROWE, PH.D., Supervising Principal of the Lovell District, New Haven, Conn.; formerly Professor of

Pedagogy and Director of Practice in the State Normal School at Mankato, Minnesota. New York, The Macmillan Co.; London, Macmillan & Co., Ltd. 1899. Price, $1.00.

The strictly scientific contribution of this book is rather small, but its practical value is likely to prove very great. It is a *résumé* of many of the important results of recent studies in child psychology and school hygiene, based largely upon such authorities as the *American Journal of Psychology*, the *Pedagogical Seminary*, the *Child Study Monthly*, the *Educational Review*, and the standard books and papers on child study and school hygiene. From a scientific point of view the special contribution of the book consists in the fact that it gives the reaction of a practical teacher to the more theoretical conclusions of psychologists and students of hygiene.

Among the topics considered are the senses, motor ability, nervousness, fatigue, habits of posture, habits of movement, growth and adolescence, and school and home conditions. The more common and simple tests of the senses, of motor ability, nervousness and fatigue are given; and the commonplace teachings in regard to education and health that result from psychological study are presented in a way that is likely to appeal to teachers. The keynote of the book is stated by the author as implied in two fundamental principles of education: "One of these is that action is the first law of growth; the other, that individuals vary enormously in their capabilities for different kinds of mental and physical action."

Very few direct references to literature are made in the body of the book, and the query naturally arises whether in a work so largely based on recent studies in psychology and hygiene even the popular demand for a clean page justifies the omission of explicit reference to authorities. To the scientific student, such a lack is often exasperating, and in this case only partially atoned for by the blanket acknowledgment in the selected bibliography at the end; and some ambitious teachers may wish to know, for example, who besides the author have used the tests for hearing mentioned in chapter 3; upon the results of whose investigations of fatigue are based the suggestions (pages 80–81) 'which we may accept as practically proved'; how the author knows (p. 130) that children grow more rapidly in summer than in winter; and where Eulenberg's table of scoliosis among school children (given on p. 154) can be found. The need of such references to authority is emphasized, for example, by recent investigations upon fatigue which cast discredit upon Griesbach's method, and in many places throughout the book the weight of the author's statements would be increased by direct citation of authority.

WM. H. BURNHAM.

SOUTH AMERICAN LANGUAGES.

Der Sprachstoff der brasilianischen Grammatik des Luis Figueira nach der Ausgabe von 1687. Von JULIUS PLATZMANN. Leipzig, B. G. Teubner. 1899. Octavo. LIV., 247.

Der Sprachstoff der Guaranischen Grammatik des Antonio Ruiz übersetzt und hier und da erläutert von JULIUS PLATZMANN. Leipzig, B. G. Teubner. 1898. XX., 261. Octavo.

Chilidúgu. Lachrymæ salutares opera Bernardi Havestadt. Editionem novam immutatam curavit DR. JULIUS PLATZMANN. Lipsiae, Teubner. 1898. Pp. 78.

Los Indios Matacos y su lengua por Juan Pelleschi, con introduccion por S. S. LAFONE QUEVEDO. Dos mapas. Buenos Aires. 1897. Pp. 246.

The above mentioned publications are not facsimilarian editions of authors such as Dr. Platzmann is in the habit of issuing, but explanations in the form of translations and commentaries of vocables and grammatic forms recorded in books now difficult to obtain. Guarani and Tupi are dialects of the same family very closely related, and at the time these missionaries were composing their works Guarani was heard not only along the eastern border of Peru, but also along the La Plata, in Paraguay and on the coast of Brazil.

According to the most reliable sources Luis Figueira was born in the Portuguese province of Alemtejo in 1575, entered the seminary of Evora in 1592 and went over to Brazil in 1602. He settled in Maranhão in 1607 to found missions for the conversion of the natives, and by the year 1615 the knowledge he had acquired of Guarani enabled him to compose his 'Arte de Grammatica' of the 'Brazilian' or Guarani language. He was on the return trip to the mother country, Portugal, when he became shipwrecked at the mouth of the Amazonas, at Marajó Island, attacked by the Aroan savages and put to death on July 6, 1638.

The main part of Platzmann's volume is followed by a series of 1991 Guarani terms of Figueira translated and commented upon in German. In reading this list we often wish to have the original of the *Arte* in hand for reference.

In the preface Platzmann discusses the phonetics of that language and the characters used by the *Padre* to express certain sounds. There are also literary sketches on previous and recent Portuguese authors on Brazil, its Indians and their languages, and on the area in which Tupi is spoken at present.

Another apostle of the Roman Catholic faith among the Brazilian tribes was Antonio Ruiz de Montoya. He was born in Lima, 1583, and died there in 1652; therefore he can be considered as an American-born missionary. His earliest work appears to have been the Tesoro, a Guarani-Spanish dictionary of 814 pages, which saw the light in Madrid, 1639. This was followed next year by the *Arte* or grammar of Guarani, the Vocabulario and the Catecismo; this last was reprinted by Platzmann in 1876. The words of the language are presented, analyzed and translated in 2236 items. This part of the volume is instructive, but the part of Platzmann's preface in which he compares Guarani radicals with those of European languages contains too many fanciful ideas to meet general approval.

Having previously republished Bernard Havestadt's 'Tractatus de lingua Chilensi,' in two volumes, Dr. Platzmann was informed that his publications of Havestadt's 'Opera' were not complete without his 'Lachrymæ salutares.' So he set himself to commit this Latin religious poem, although it has nothing to do with Indian philology, to press. It is written in fine trochaic verses, which were in vogue in his time for church poetry.

Juan Pelleschi is a civil engineer, who wrote his book in Italian and had it translated in Spanish. He treats of the customs and manners of the Matacos or Mataguayos, a roving people inhabiting the Gran Chaco, not in a strictly scientific manner, but in a colloquial way. This may be said also of his treatment of the Mataco language, which is identified with the Tonocoté. We find no paradigms of nouns or verbs, no rules, exercises, etc., but the character of this tongue is developed at length and in a general way without any strict plan or method. Of the two maps the first is a reproduction of an ancient map and exhibits in an excellent manner the early distribution of tribes on the Gran Chaco. A Spanish-Mataco and a Mataco-Spanish vocabulary concludes the publication.

ALBERT S. GATSCHET.

SOCIETIES AND ACADEMIES.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

AT the 508th meeting of the Society, held on December 9th, at the Cosmos Club, biographical sketches of Mr. Edward Goodfellow and of George Brown Goode, were read; the former by Mr. H. G. Ogden, and the latter by Mr. Cyrus Allen. The regular papers of the evening were by Mr. E. D. Preston on the 'Language of Hawaii,' by Mr. F. H. Bigelow on 'Results of Recent Exploration of the Upper Atmosphere,' and by Mr. G. W. Littlehales on 'Possible Methods of Measuring the Resultant of the Centrifugal and Gravitational Forces on the Ocean.' The first paper dealt with the Polynesian languages in general and the Hawaiian in particular, from the standpoint of comparative philology. Similar constructions were followed out in the Oceanic and Indo-European tongues, and points of contact were noted between modern Hawaiian, on the one hand, and French, German, Spanish, Italian and English, on the other. In the last paper the author, after recounting the trials that were made by Mascart, nearly twenty years ago, to determine the variation of the force of gravity from place to place by means of a siphon barometer whose short arm was closed and contained a certain quantity of gas, referred to the experiments that have lately been made by Mohn of Christiania, according to a method that was reported to the U. S. Coast and Geodetic Survey, in 1890, by

Assistant Superintendent Tittmann, with a view to finding the gravitational correction in mercurial barometric readings by comparing the atmospheric pressure as indicated by the mercurial column with the true atmospheric pressure as deduced from the temperature of unconfined steam. He then proceeded to relate his own considerations and experiments concerning the possibility, in times of exceptional calm at sea, of using the Electric Clepsydra for the measurement of the relative quantities of mercury discharged in equal intervals of time at different places from an orifice in the bottom of a vessel of comparatively large cross-section, and also concerning the possibility of ascertaining the changing relation, with change of place between a given mass, and its weight, by the use of a modification of the standard aneroid barometer in which the vacuum chamber has been replaced by a heavy mass.

E. D. PRESTON,
Secretary.

ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 296th regular meeting of the Society was held Tuesday evening, December 5, 1899.

Miss Alice C. Fletcher read a paper on 'The Building of the Earth Lodge' describing its minute structure, purpose and variety.

Dr. Washington Matthews read a paper on 'The Earth-Lodge in Art,' in which he stated that the earth-lodge was the most commodious aboriginal structure existing in America north of New Mexico. Henry in 1807 measured one in the old Mandau Village at Knife River which was 90 feet in diameter. Thousands of such lodges, inhabited by tribes of widely different stocks, existed in the Mississippi Valley at the time of the Columbian discovery ; their remains are scattered from North Dakota to Louisiana and from Western Kansas to Eastern Tennessee.

Dr. Matthews stated that the embellishments in works of ethnography and travel were often false, and tended to lead the student astray rather than to aid him. He gave a number of general instances of false illustration in ethnography, but spoke chiefly of the misleading pictures of the earth-lodge published in various works. He exhibited pictures taken from the works of Gass, Catlin, De Smet and Morgan, and compared them with photographs of the real lodge. The most faithful pictures of the lodge not photographic were those of Mr. Bodmer, the artist who accompanied the Prince of Méd.

Mr. Jas. Mooney read a paper entitled 'The Earth-Lodge in the Gulf States.'

J. H. MCCORMICK,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

AT the 314th meeting on December 16th, Lester F. Ward spoke of 'the Fossil Forests of Arizona,' saying that they were of Mesozoic age, the strata containing the petrified trunks ranging from just above the Permian up to and including the Upper Trias; the formation extended northwards into Utah. The territory in which the petrified forest lay was in Apache Co., east of Holbrook, but while the trunks were found over a very considerable tract the best portion of the 'Forest' was embraced in an area about eight miles square. In some portions of this the petrified logs lay much more thickly than they could have stood when living. In fact these trees did not lie where they had grown, but had been transported thither in Mesozoic time by strong and swift currents and had then been rapidly buried in sand. The trees were completely silicified and so well preserved that the microscopic structure could be clearly made out, showing that they were related to the Araucarian Pine of the Southern Hemisphere; hence the genus had been named *Araucari oxylon.* The speaker stated that his recent visit to the petrified forest was the result of a request from the General Land Office for a report as to the desirability of reserving the most interesting portion as a national park, a memorial to Congress to that effect having passed the Legislature in 1895. Owing to the visits of tourists, the more beautiful specimens were being steadily carried away and destroyed, while many car loads had been removed to be cut, polished and made into ornaments. Owing to the extreme hardness of the silicified trunks, it had been proposed to utilize them in the manufacture of a substitute for emery, and a crushing plant had actually been erected, although never operated, owing to the development of the corundum industry in Canada.

Ex-Governor W. A. Richards, Assistant Commissioner of the General Land Office, who was present and was invited to speak, said that the Land Office was in earnest in this matter and was glad to have a truly scientific report on the subject. He stated that a very large amount of the material was now being worked up in this country into articles to be sold at the coming Paris Exposition.

F. A. Lucas described 'Blue Fox Trapping on the Pribilofs,' saying, that Mr. James Judge, Treasury agent on St. George Island, had experimented extensively in the feeding and trapping of foxes, and had devised methods by which they could be readily taken alive, so that the females could be liberated, as well as a certain proportion of the males, the other males being killed. The entire paper will appear in SCIENCE.

M. B. WAITE described a 'Soil Inoculation Experiment with Soy Beans,' in testing the effect of imported Japanese soil on the Soy bean. This plant is a native of Japan and in that country forms root tubercles abundantly. In this country the plants commonly do not form root tubercles, for the reason that the necessary germs do not exist in American soils. The Soy bean is thus unable to gather free nitrogen after the manner of other Leguminosæ.

Soil was imported from a Soy bean field in Japan and sown in small quantities in the drill with the seed. The experiment was tried on a newly cleared piece of sandy land poor in combined nitrogen, and the results were quite striking. The plants in the control rows at harvest time plainly showed nitrogen starvation. In the rows inoculated with Japanese soil the plants were larger, leafier and darker green in color. They showed the effects of nitrogen fertilization. On examining the roots they were found to be well supplied with the nitrogen, gathering tubercles, while the check plants had few or none. The comparative weight of the treated and untreated portions was as 14 to 8 in favor of the treated plants.

O. F. COOK,
Secretary.

ONONDAGA ACADEMY OF SCIENCE.

THE November meeting of the Academy was addressed by Dr. J. M. Clarke, the New York State paleontologist. He gave briefly a history of the work accomplished by the geological survey of the State from its inception in 1842 to the present time, and explained in detail the new system of nomenclature proposed for the State, giving reasons for accepting the same. The latter part of the address was devoted to an account of the transitional fauna of the Portage and Chemung formations.

At the meeting of the Geological Section Mr. C. E. Wheelock read a paper on 'The Marls of Onondaga County.' He showed that the principal deposit crossed the county just north of its center and in an east and west direction, corresponding quite closely with the southern extent of the extinct Lake Iroquois. The beds in the western part of the county were studied in detail, and would seem to bear out the theory that there had occurred several oscillations of the lake shore. Excavations within the limits of Syracuse seem to corroborate the same theory. Mr. Wheelock believed that this marl deposit was cotemporaneous in formation with the existence of Lake Iroquois. The few isolated and small deposits in other parts of the county he held to be of different and probably more recent formation.

At the December meeting Dr. W. M. Beauchamp spoke on local archæology. He said that the village sites and their approximate dates of occupation could be traced by the relics found on the various sites. As the Onondagas occupied usually only one village, their migrations are more easily traced than tribes consisting of several villages. The occurrence of implements of walrus tusks, and also a peculiar variety of stone knife, prove beyond reasonable doubt that the Eskimos were earlier inhabitants, even if only temporary, than the Indians.

Dr. W. G. Hinsdale described the character of relics found on local sites, speaking more particularly of the harpoons, barbed fish-hooks and other polished bone implements. Grooved axes are only rarely found in this section, and implements are seldom found buried with the skeletons unearthed.

H. W. BRITCHER,
Corresponding Secretary.

THE PHILOSOPHICAL SOCIETY OF THE UNIVERSITY OF VIRGINIA.

THE regular monthly meetings of this society have begun. At the first meeting of the present session the following officers were elected for the current year:

President, Dr. C. W. Kent; Vice-president, Professor W. H. Echols; Secretary, Dr. W. J. Humphreys.

After the election of officers, Professor Ormond Stone delivered the customary address of the retiring president. His subject was *The Moon*. His address, supplemented by many excellent photographs, was a clear presentation of the more recent theories in regard to the markings on the moon's surface, and probable past and future history of the moon's relation to the earth.

The second meeting, December 8th, was devoted to meteors. Professor Ormond Stone gave a brief outline of the preparations made under the auspices of the Leander McCormick observatory for studying the Leonid meteors. These included, among other things, six photographic stations on a north and south line about forty miles in length.

Dr. M. W. Humphreys explained his methods of making and recording eye-observations of meteors, and called attention to several very singular meteors--about half a dozen in all--seen on the nights of November 14th and 15th. These were all red and moved in wavy lines, the amplitudes being approximately one degree. It was admitted that this might be an optical illusion, but if so, not peculiar to the observer, as in the case of the most conspicuous meteor of this type the same phenomenon was noted by at least one other member—a young lady—of the party.

Dr. W. A. Lambeth gave an account of a shower of meteors he saw in November, 1892, in North Carolina. He said it was about eleven o'clock at night and that they appeared far too rapidly to allow even a guess at the number—that they presented the appearance of a veritable rain of fire, so much so that for a time the engineer of the train he was on refused to run his engine, and that the negroes, as in 1833, indulged in song and supplication, believing firmly that the end of the world had come.

Mr. J. A. Lyon gave a short history of the Leonid meteors, covering a period of about one thousand years.

Dr. W. J. Humphreys, described the photographs obtained, all of which, with possibly one exception, failed to show meteor trails. Several practical points were learned, however, and these were stated in view of the fact that renewed efforts will be made next year to photographically determine the radiant and the height of the atmosphere.

At the close of the meeting Professor F. L. O. Wadsworth, director of the Allegheny Observatory, showed to those interested a curved star negative of Orion and adjacent regions which he had recently taken. This remarkable negative, due to the combined skill of Wadsworth and Brashear, has, in excellent definition, more than one thousand square degrees, and shows, according to their estimation, more than 50,000 measurable stars.

W. J. HUMPHREYS,
Secretary.

ALABAMA INDUSTRIAL AND SCIENTIFIC SOCIETY.

THE regular autumn meeting of the society was held in the rooms of the Commercial Club, in Birmingham, on the afternoon of November 16, 1899.

Mr. T. H. Aldrich, ex-president of the society, in the chair. Present, Messrs. J. A. Montgomery, B. B. Ross, Col. Horn, E. A. Smith and representatives of the press. The reading of the minutes of the last meeting (annual) was dispensed with, as the proceedings of this meeting had already been printed and distributed. The Secretary made the statement that on the occasion of the spring meeting so few members and officers were present that it was decided not to have a meeting, notwithstanding the fact that Dr. Ross was present with a paper and Mr. James Bowron had consented to talk to the Society about Cuba.

After the regular routine, Dr. Ross gave an abstract of his paper on 'The Fertilizer Resources and Fertilizer Industries in Alabama.' This valuable paper will be printed in full in the Proceedings. Dr. Ross also exhibited to the members a number of samples of phosphate rock collected recently by him in the vicinity of Athens, in Limestone County. The samples analyzed by him contained from 15 to 20 per cent. of phosphoric acid up to 36 or 37 per cent.; and he also showed a sample of superphosphate prepared by him from this rock, the manufactured article containing 13.15 per cent. water—soluble, 0.15 per cent. reverted, and 1.24 per cent. insoluble; total 14.9 per cent. phosphate.

In the discussion which followed, Mr. Aldrich said that a fertilizer manufactory in Meridian was using lignite from the Burning Cut in Sumter County, Ala., as a filler, and that it contained 1.5 to 2.0 per cent. ammonia. Mr. Aldrich had formerly sold from the Blocton mines several hundred tons of coal slack, to a Shreveport company, for the same uses. He also mentioned the fact that he had recently examined a lignite occurring in Mississippi, 17 miles west of Starkville, which had only 4.5 per cent. of ash and which made a very good coke.

Dr. Smith then read a preliminary report of the mineral statistics of Alabama for the second and third quarters of the current year; after which, there being no other business before the meeting, it was adjourned *sine die*.

EUGENE A. SMITH,
Secretary.

DISCUSSION AND CORRESPONDENCE.

DR. WILSON'S REPLY TO HIS CRITICS.

I CONSIDER it complimentary to an author that his works should be criticised. It shows that they are worthy of attention and consideration. The friendly criticism in SCIENCE, December 22d, of my address delivered in Columbus last August, before the Section of Anthropology of the A. A. A. S., appears under such misapprehension as seems to require a word of explanation. That address, as its title indicates, was 'A History of the Beginnings of the Science of Prehistoric Archæology.' It was a *résumé* or description of the discoveries made, or alleged to have been made, which led to the foundation of the science, and a statement of the theories advanced for its establishment. This being its purpose, it was proper that I should treat of all its topics, and this without binding me to an approval of them. I was recording a history of the science, not necessarily maintaining the truth of all the theories advanced by its founders. The friend who wrote the criticism seems not to have recognized the difference. He makes strenuous opposition to the classifications of the science as set forth in my address; but none of them were mine. They had been made in Europe many years since, were applicable to that country, and most of them are still in use there. In such a history as I was writing it would have been highly objectionable for me to have omitted them; and so with most of the other points in the criticism referred to.

THOMAS WILSON.

NOTES ON INORGANIC CHEMISTRY.

AN important practical application of the liquefaction of hydrogen is that of the production of high vacua, as described by Dewar in the *Proceedings* of the Royal Society. At the boiling point of hydrogen the vapor tension of air is less than a millionth of an atmosphere, hence when to vacuum tubes for the spectroscopic examination of gases is attached a temporary tube immersed in liquid hydrogen, the solidification of the air in the tube produces a very high vacuum. In this way the more volatile constituents of atmosphere become concentrated in the tube, and in numerous tests the presence of neon and of helium was revealed in a volume of air less than 50 cc. Some tubes showed a hydrogen spectrum, but others did not, so that the question as to whether free hydrogen exists in the atmosphere cannot be considered as settled.

A LATER number of the *Proceedings* contains a paper by T. G. Bonney on the parent-rock of the South African diamonds. The 'blue ground' of the Newlands mines, which are forty miles northwest of Kimberley, contains rounded boulders of eclogite, and in this eclogite are occasional colorless octahedra of diamond, apparently as an original constituent. As the eclogite boulders are water-worn, it follows that the 'blue ground' is not of igneous origin, but it is true breccia produced by the destruction of various rocks, one of which—the eclogite—has contributed the diamonds to the mixture.

THE analysis of a sample of Egyptian porcelain from Memphis is published by Le Chatelier in the *Comptes Rendus.* The composition is found to be wholly different from that of Chinese porcelain, and hence it would appear that the manufacture of true porcelain was known to the ancient Egyptians. The duplication of this Egyptian porcelain would require 40 parts blue glass, 50 parts fine sand, and 5 parts white clay.

Le Chatelier has also examined statuettes from Egyptian tombs which were supposed by Salvétat to be carved from a natural grit and then glazed with a sodium-calcium-copper silicate. It appears, however, that the statuettes from several different localities consist chiefly of fine grains of quartz sand, with a little clay as a binding material. The glaze is a mixture of sand with a sodium-copper silicate.

The effect of sulfur, especially as pyrites, in coal when used as a fuel is discussed by Wilhelm Thörner in the *Chemiker-Zeitung.* With such a fuel, not only sulfur dioxid, but also sulfuric acid will be present in the combustion products. Since at least a portion of this sulfuric acid will be deposited upon the boiler walls, tubes, etc., it is necessary that these should be cleaned frequently. The more moisture present, the greater the corrosive action of the acid. If lime is mixed with the coal, the formation or at any rate the deposition of the acid is in large part prevented. The author suggests the use of briquettes made of an intimate mixture of coal with a little lime. With these not only can fine coal screenings, slack, etc., be used, but sulfuric acid corrosion may be practically avoided.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

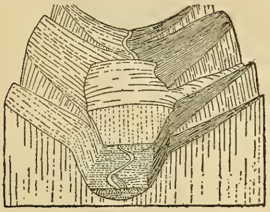
In resuming the preparation of these notes after an interruption of a year and a half, it will not be possible to mention all the physiographic essays published in the interval, but the effort will be made to give account of the more important ones in which the readers of Science may be interested, as well as to review current publications.

GLACIAL SCULPTURE IN WESTERN NEW YORK.

Gilbert concludes that the Niagara limestone upland in western New York is chiefly a product of pre-glacial erosion, but that its relief has been increased by the greater glacial erosion of the lowland underlaid by weaker shales on the north, and that its northward-facing escarpment has been modified in detail by glacial action. Where the escarpment faces northwesterly, so that the ice sheet moved about parallel to its front, the outline has been smoothed; where it faces northeasterly, against the ice motion, preglacial irregularities are intensified by glacial scouring. The plain of Medina shale bordering Lake Ontario, and now overspread with drift and lacustrine strata, has a broadly furrowed rock floor, with troughs parallel to the ice motion: here the minimum estimate of the general reduction of the surface by glacial erosion is set at 40 or 50 feet, 10 or 20 times its measure on the limestone upland (Bull. Geol. Soc. Amer., X., 1899, 121–130).

GLACIATED VALLEYS.

The most original physiographic essay presented to the recent International Geographical Congress at Berlin was one by Penck on the over-deepened valleys of the Alps. Not only where large lakes occur near the margin of the mountains, but far inward along the larger rivers, the main valley floors are deepened below the level of the side valley floors and the discordance thus indicated is ascribed to the stronger glacial erosion in the main than in the side valleys. The side streams plunge down into the main valley as waterfalls. This discordance of valley floors at first seems exceptional, characterizing valleys of glacial erosion but not of river erosion: but it was well shown that there is no such failure of analogy. A river of water moves nimbly; its cross section is small and its channel is a small part of its valley; the river bed is usually hidden, and hence, as main and side streams have the same surface level at their junction, we do not ordinarily notice that the bed of the main river channel is deeper than that of a side stream, although this relation must be recognized as soon as attention is turned towards it. A river of ice moves slowly; its cross section is large and its channel is a large part of its valley; ancient glacial channels are now habitually laid bare, and the discordance between the beds of the main and the tributary channels becomes very striking, while we lose sight of the accordance that must have prevailed in the confluent



surfaces of the main glacier and its tributaries. The river channel as well as the glacial channel is U-shaped, but the abandoned glacial channel is so large that it often gives name to the valley in whose bottom it is eroded. The accompanying diagram roughly presents the form of an Alpine valley in preglacial (background), glacial (middleground), and postglacial (foreground) time.

THE heavy glaciation of valleys eroded in the massive gabbros of Skye has produced the following features, as noted by Harker (Geol. Mag., London, 1899, 196–'99). The cross-section of the valleys is U-shaped, especially in their upper part. The head of the valley expands in a corrie (cirque or amphitheatre) whose floor is often a rock-basin holding a tarn. In longitudinal profile, the floor of a valley often consists of two or three stretches of relatively gentle slope (or even of basin-form) separated by relatively sudden descents. Tributary valleys mouth at a considerably higher level than the floor of the main valley. McGee's paper on 'Glacial Cañons' (*Journ. Geol.*, II., 1894, 350–364), referred to by Harker, may be read to advantage in this connection.

It is noteworthy that the discordance of side and main valleys, emphasized by Penck as a characteristic of glacial action, and clearly recognized by McGee and Harker, has been mentioned in but few essays on glacial erosion; yet it can hardly be doubted that such discordance is one of the most striking features of strongly glaciated mountain regions.

ANCIENT VALLEYS OF NORTHEASTERN GERMANY.

THE origin of many broad valleys in northeastern Germany, as determined by ancient rivers flowing westward, marginal to the retreating ice-sheet of the last glacial period, has lately been restated by Keilhac (*Verh. Gesellsch. Erdk.*, Berlin, XXVI., 1899, 129–139, map), with fuller detail than was given in the earlier explanations by Berendt and Girard. Five important valley courses are traced, exterior to five morainic belts; the southernmost connects the Oder at Breslau with the Elbe above Magdeburg; the northernmost led the Oder from Stettin northwest to Ribnitz and south again from Lübeck to the Elbe at Lauenburg. Lakes are indicated by horizontal shore-terraces at certain depressed areas along the valley courses, where the present northward discharge was ice-barred. The ancient ice-margin valleys owe their considerable breadth to the large volume of the rivers that were then supplied by melting ice on the north as well as by rainfall on the south. The rivers of to-day follow the ancient marginal valleys for moderate distances only, and then turn northward through depressions that were opened to them as the ice melted back; sometimes again turning westward for a stretch along the next marginal valley that is encountered. Thus sub-rectangular bends to the right and the left are systematically repeated seven times by the Oder, between Breslau and Stettin.

W. M. DAVIS.

ZOOLOGICAL NOTES.

MR. C. W. ANDREWS, in a recently issued part (Vol. XV., part 3), of the Transactions of the Zoological Society of London, describes at length and figures the skull and portions of the skeleton of *Phororhacos inflatus*, one of the gigantic extinct Patagonian birds. In discussing the relationship of the genus, which is put among the *Gruiformes*, Mr. Andrews shows a decided leaning toward *Cariama*, saying that the relations of the one toward the other are much the same as those of the extinct *Glyptodon* and *Panocthus* towards existing armadillos. Mr. Andrews will be glad to know that among the material obtained for Princeton University by

Mr. J. B. Hatcher, is a small species of *Phororhacos*, or some closely allied genus, in which the sternum is preserved, that this sternum is slightly keeled, and, although no critical comparisons have been made, that the general aspect of the sternum is like that of *Cariama* or *Gypogeranus*. F. A. L.

THE MALARIA EXPEDITION TO WEST AFRICA.

Major Ronald Ross, the lecturer to the Liverpool School of Tropical Diseases, who recently headed the malaria mission to Sierra Leone, delivered an address on December 27th at Liverpool, on the invitation of the African trade section of the Liverpool Chamber of Commerce. His subject was 'The Recent Medical Expedition to West Africa.' According to the London *Times* Major Ross said that politics and science were culminating in two movements of high importance. In politics the Great Powers, tired of self-development, were endeavoring to extend their possessions and civilization all over the world; while in science they had created what was perhaps the most fundamentally important of all knowledge—the experimental science of disease. He believed that in the coming century the success of Imperialism would depend largely upon success with the microscope. Our possessions in Africa were battle grounds between Englishmen and king malaria: they were conquests maintained only at the sacrifice of hecatombs of our countrymen. Malarial fever was perhaps the most important of the diseases of the tropics. For a long time they could obtain no accurate knowledge as to how the disease was produced, but in the last two years they had ascertained definitely at least one mode of infection. They knew for certain that malarial fever was often, perhaps always, caused by the bite of the species of gnat or mosquito called anopheles. The object of the expedition from the Liverpool School of Tropical diseases was to ascertain whether there was any chance of exterminating the anopheles from a given malarious area. It was not the immediate purpose, as some supposed, to banish malaria then and there from the whole continent of Africa. They wished to inquire what could be done in two or three square miles. They selected Free Town, Sierra Leone, for the investigation, and reached there last August. After describing Free town, Major Ross said that the mission set themselves to work at once on the lines of the recent investigations in India and Italy. In a few days they found numbers of the anopheles, and in a few days more they discovered the germs of malaria actually within those insects. They knew then to an absolute certainty that the anopheles of Sierra Leone were responsible at least for a large part of the fever there. The next thing was to ascertain how they bred. Those very dangerous insects bred in small pools or puddles of a certain kind easy to detect when one had once seen them. They made a map of those pools and carefully studied the habits of the insects' larvæ. The conclusion they unanimously came to was that it would probably be an easy and inexpensive matter to rid the town almost entirely of the anopheles either by destroying the larvæ in the puddles or, bettter still, by draining away the puddles altogether.

Comparing the general mode of life of Europeans in Sierra Leone and India, Major Ross said that, though Sierra Leone was scarcely more fatal to Europeans than some parts of India, it was certainly much more unhealthy than the large majority of Indian towns and cantonments were. He confessed that after a service of many years in India and Burma he was much struck with a certain negligence in respect to some matters in Africa. In India Englishmen had learned how best to live in tropical countries. They had certain fixed institutions which they seldom did without. He referred to the commodious bungalow, with its large compound, the punkah, and the mosquito netting on the beds. There was no doubt all those were of great assistance, but in Sierra Leone he was astonished to find none of those things, at least in general use. Instead of there being a separate European quarter on the highest ground available and consisting of well-built houses each in the midst of an open garden, most Europeans in Freetown occupied poor wooden structures quite unfit for English people in that pestiferous climate, crowded together and mingled with the houses of the townspeople (who had not the same reason to dread the malaria), and in the very lowest, dampest and hottest part of the town. The Governments and the great commercial houses who sent *employés* to the tropics and paid their expenses—especially their funeral expenses, which were considerably larger than the mere cost of the hearse—should have something to say on the matter. The nation had not paid sufficient attention to the shocking mortality in its tropical possessions. They shuddered to hear of a few guinea-pigs being inoculated with disease in the laboratory, but looked on with indifference at the infection by natural means of thousands of their countrymen and of millions of our colored subjects in the tropics. They spent floods of money in the tropics on what was called sanitation and maintaining costly medical service, but such expenditure was more or less perfunctory; it was part of the Budgets, and it was allocated without much intelligence, and he feared, largely wasted. Fifty years ago a new parasite called the ankylostoma duadenale was discovered. It was now known, chiefly as the result of investigation by private persons, to cause an immense amount of sickness and mortality among our colored subjects. Although the presence of the parasite could easily be detected by the microscope, its name hardly found a place in our statistics of disease. A few years ago Giles studied the mode in which it gained an entry into our bodies. Since then no one had repeated his observations or taken the slightest interest in them. It had not been thought worth while to check the ravages of that disease. Again, some years ago a parasite was found which might perhaps cause that terrible and widespread disease, dysentery. No attempt had been made by Englishmen to clear up that important point; and the life-history of the parasite which was studied years ago by Cunningham seemed to have been completely forgotten. Twenty years ago Manson ascertained that the parasite which caused elephantiasis was carried by the mosquito. Until last year not a single person had made any adequate attempt to verify his work—much less to act upon it for the prevention of the disease. In India alone the mortality ascribed to fever was five million persons annually. Besides the mortality vast tracts of fertile possessions were rendered uninhabitable by this disease. Twenty years ago the parasite which caused the disease was found, but not a microscope or pen was used by Englishmen for seven years. During those seven years 35 million persons died from fever in India alone. Then a single Englishman, Vandyke Carter, took up Laveran's discovery. He was now dead. For that and other noble work he received no reward. Not another Englishman moved in the matter for another seven years, lazy, indifferent, and imbecile scepticism holding the ground. Then a few young countrymen of ours commenced to study the subject, years after other great nations had been attacking it with vigor, and now they did find medical men and others who paid some attention to it in the British dominions. Now there was an awakening everywhere. The Royal Society itself, assisted by Mr. Chamberlain and the Colonial Office, had taken up the matter with energy. The tropical schools of London and Liverpool had been founded by leading citizens, and scientific missions were being sent to different parts of the world. He had spoken that day in the hope of increasing sympathy in the great cause. A thousandth part of the energy now spent on numberless philanthropic schemes in Great Britain was likely at that moment to produce a thousand times as much fruit if properly expended in the cause of imperial sanitation. They had much reason to hope that in a year or two they would not only have a complete knowledge of how malaria was produced, but would foresee a cheap and practical mode of prevention.

NAVY REPORT ON WIRELESS TELEGRAPHY.

THE U. S. Navy Board has reported on the Marconi system of wireless telegraphy as follows: It is well adapted for use in squadron signaling under conditions of rain, fog, darkness and motion of speed. Wind, rain, fog, and other conditions of weather do not affect the transmission through space, but dampness may reduce the range, rapidity and accuracy by impairing the insulation of the aërial wire and the instruments. Darkness has no effect.

We have no data as to the effects of rolling and pitching, but excessive vibration at high speed apparently produced no bad effect on the instruments, and we believe the working of the system would be very little affected by the motion of the ship. The accuracy is good within the working ranges. Cipher and important signals may be repeated back to the sending station, if necessary, to insure absolute accuracy. When ships are close together (less than 400 yards) adjustments easily made of the instruments are necessary. The greatest distance that messages were exchanged with the station at Navesink was 16.5 miles. This distance was exceeded considerably during the yacht races, when a more efficient set of instruments was installed there. The best location of instruments would be below, well protected, in easy communication with the commanding officer. The spark of the sending coil or of a considerable leak, due to faulty insulation of the sending wire, would be sufficient to ignite an inflammable mixture of gas or other easily lighted matter, but with the direct lead (through air space, if possible) and the high insulation necessary for good work, no danger of fire need be apprehended.

When two transmitters are sending at the same time, all the receiving wires within range receive the impulses from transmitters, and the tapes, although unreadable, show unmistakably that such double sending is taking place. In every case, under a great number of varied conditions, the attempted interference was complete. Mr. Marconi, although he stated to the Board before these attempts were made that he could prevent interference, never explained how nor made any attempt to demonstrate that it could be done. Between large ships (heights of masts 130 and 140 feet) and a torpedo boat (height of mast 45 feet), across open water, signals can be read up to seven miles on the torpedo boat and eighty-five miles on the ship. Communication might be interrupted altogether when tall buildings of iron framing intervene. The rapidity is not greater than twelve words per minute for skilled operators. The shock from the sending coil of wire may be quite severe and even dangerous to a person with a weak heart. No fatal accidents have been recorded. The liability to accident from lightning has not been ascertained. The sending apparatus and wire would injuriously affect the compass if placed near it. The exact distance is not known and should be determined by experiment. The system is adapted for use on all vessels of the navy, including torpedo boats and small vessels, as patrols, scouts and despatch boats, but it is impracticable in a small boat. For landing parties the only feasible method of use would be to erect a pole on shore and then communicate with the ship. The system could be adapted to the telegraphic determination of differences of longitude in surveying. The Board respectfully recommends that the system be given a trial in the navy.

SCIENTIFIC NOTES AND NEWS.

WE record with much regret the death of Dr. Elliott Coues, the eminent naturalist, on December 25th, in his 57th year.

A MEMORIAL meeting in honor of the late Daniel G. Brinton will be held in Philadelphia on January 16th, under the auspices of the American Philosophical Society, and with the coöperation of some twenty-four societies. A portrait of Dr. Brinton, a memorial medal and a set of his works will be presented to the Philosophical Society.

PROFESSOR E. B. WILSON, of Columbia University, has been elected president of the American Society of Naturalists, in succession to Professor W. G. Farlow, of Harvard University.

DR. WILLIAM MCMURTRIE, of New York City, has been elected president of the American Chemical Society, in succession to Professor Edward W. Morley.

THE New Year's honors annually conferred in Great Britain include a peerage for Sir John Lubbock, a knighthood for Dr. T. Lauder Brunton, the physiologist, and a K. C. B. for Captain W. de W. Abney, the physicist, assistant Secretary of the Science and Art Department.

A MOVEMENT has been started in Baltimore to pay some special tribute to President Daniel Coit Gilman of Johns Hopkins University, in honor of the twenty-fifth anniversary of his connection with the University, which occurred on December 31st.

PROFESSOR C. H. EIGENMANN, director of the Indiana University Biological Station, since its establishment, has severed his connection with the Station, and Dr. R. E. Lyons, professor of chemistry, has been appointed as his successor.

PROFESSOR R. W. WOOD of the University of Wisconsin, has accepted an invitation to lecture before the Royal Photographic Society, London, and will leave New York early in January to be absent about six weeks.

PROFESSOR WILLIAM JAMES, of Harvard University, and Professor G. T. Ladd, of Yale University, have been elected delegates from the American Psychological Association to the International Congress of Psychology meeting next year at Paris.

DR. J. W. GREGORY, of the Natural History Museum, South Kensington, has been appointed to the chair of geology in the University of Melbourne, vacant by the death of Sir. J. M'Coy. It is an open secret that Dr. Gregory applied for the post because the trustees of the British Museum refused to recommend him for the position of a first-class assistant, while they at the same time checked the flow of promotion by retaining Henry Woodward as head of the Geological Section of the Museum after the time for his retirement under the age limit. Dr. Gregory will receive four times the salary at Melbourne that he has been receiving at the British Museum, and will have excellent opportunities for research in Victoria. It appears, however, that the trustees of the British Museum have made a serious mistake in refusing to promote from a second-class assistantship a naturalist whose work as explorer and scientific investigator has already won him distinction, and whose services to the Museum during the past twelve years have been most important.

MR. JAMES LYMAN WHITNEY, who for over thirty years has been connected with the Boston Public Library, has been elected librarian in the place made vacant by the removal of Mr. Herbert Putnam to the National Library, Washington. Mr. Whitney is a brother of the late Josiah D. Whitney, professor of geology at Harvard University, and of the late William Dwight Whitney, of Yale University.

A CABLEGRAM from London announces the death of Sir James Paget, the distinguished surgeon. He was born at Great Yarmouth, January 11, 1814, being the son of a merchant of that city. In 1836 he became a member of the Royal College of Surgeons, and seven years later, after he had made a reputation by some novel and brilliant operations, he was made an Honorary Fellow of the Institution. Among his works are the 'Pathological Catalogue of the Museum of the College of Surgeons,' 'Report of the Results of the Use of the Microscope,' published in 1842, and 'Lectures on Surgical Pathology,' published in 1853, 1863 and 1868. He was also an extensive contributor to the 'Transactions' of the Royal Society, of which he was a Fellow. In 1875 he was elected President of the Royal College of Surgeons, and from 1884 to 1895 he was Vice-Chancellor of the University of London. He was created a Baronet in August, 1871.

THE following have been elected officers of the Society for Plant Morphology and Physiology for the coming year: *President*, Dr. D. P. Penhallow, McGill University, Montreal; *First Vice-President*, Dr. Roland Thaxter, Harvard; *Second Vice-President*, Dr. Erwin F. Smith, Washington, D. C.; *Secretary*, Dr. W. F. Ganong, Northampton, Mass.

THE officers of the American Psychological Association for the ensuing year are: *President*, Professor Joseph Jastrow of the University of Wisconsin; *Secretary*, Dr. Livingston Farrand of Columbia University; *Council*, Professors Ladd, Bryan, Gardiner, Cattell, Delabarre and Kirschmann.

THE members of the American Society of Naturalists voted to invite the members of the American Society, at present in session at Chicago, to constitute the Western branch of the American Society of Naturalists.

THE Society of Gymnasium directors, which met in New Haven last week, will hereafter be affiliated with the societies meeting with the Naturalists. The question of uniting with the Anthropological Section of the American Association was referred to a committee.

A JOINT meeting of the Philadelphia County Medical Society, and the Pennsylvania Society for the Prevention of Tuberculosis will be held at the New Century Club on Wednesday, January 10th. Prominent speakers, both medical and lay, will take part in the discussion. Among the speakers are Dr. Otis, of Boston, Dr. Osler, of Baltimore, and Judge Ashman, of Philadelphia.

THE post of assistant physician in the government Hospital for the Insane with a salary of $1200 will be filled by Civil Service examination on February 6th and 7th.

THE Göttingen Academy of Sciences offers a prize of 1000 Marks for a mathematical paper to be submitted before the first of February 1901. The details can be obtained by addressing the Secretary.

THE world at large, and even many of those who are interested in the history of mechanical engineering, says the *Scientific American*, do not know that the body of the great engineer, Robert Fulton, lies in Trinity churchyard in New York City, being interred in the Livingston family vault. There is no mark or inscription to indicate its resting place. In view of the epoch-making character of the work of Fulton, and of his eminence as an engineer, and of his indomitable perseverance in the development of steam navigation in the face of the greatest obstacles, it has been deemed desirable that his tomb should be marked by a suitable monument. The Council of the American Society of Mechanical Engineers had the matter brought to its attention at the Washington meeting last May. The idea was warmly welcomed, and a committee was appointed to investigate the proper method of accomplishing the suitable marking of the grave. The committee has found its efforts heartily met both by the Trinity corporation and by members of the Fulton family. The Society has been assured that a suitable place will be provided in Trinity churchyard for such a monument as may be erected, and that the remains of Fulton will be removed to such a place when the monument is ready. The Society possesses a number of memorials of Robert Fulton, including furniture, his portrait by his own hand, drawings, autograph letters, and other personal relics. Indeed, it may be said that the Society is Fulton's literary heir. In view of this fact, the action of the Society is most dignified and fitting. A subscription is now being raised by it, and there is little question but that sufficient funds will be obtained to erect a most admirable memorial to mark the place where lies the body of one of the earliest and greatest of American engineers.

It is poetic justice that Fulton should continue to rest in the spot where he was interred. At the front of the quaint old burying ground run the cable cars, at the rear the electric cars and the elevated road, and at the foot of Rector Street, the other boundary, two of the fastest vessels on the bay make their landings. Almost across the street is one of the tallest buildings which has ever been erected, and Wall Street commences directly in front of the burying ground. What more fitting spot could be obtained for the resting place of one whose activities contributed in so large a degree to the progress which is so much in evidence immediately around the historic old church?

UNIVERSITY AND EDUCATIONAL NEWS.

THE University of Pennsylvania has received a gift of $250,000 from the estate of the late H. H. Houston, formerly a trustee and a generous benefactor of the University. Fifty thousand dollars is to be used for the dormitory system; the remaining $200,000 for such purposes as the trustees may desire.

PLANS have been filed for a new building for the Horace Mann School, the model school of Teachers College, Columbia University. The estimated cost is $350,000; the building will occupy the block on Broadway between 120th and 121st Street, adjoining the College.

O. H. INGHAM, of La Crosse, Wis., has given $15,000 toward the building of a new school of science for Ripon (Wis.) College.

THE new laboratories for bacteriology and pathological research at Mason University College, Birmingham, were opened on Wednesday, December 6th. Dr. E. Rickards gave £1,000 toward the equipment.

SCIENCE

Friday, January 12, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE CENTURY'S PROGRESS IN APPLIED MATHEMATICS.**

I.

The honor of election to the presidency of the American Mathematical Society carries with it the difficult duty of preparing an address, which may be at once interesting and instructive to a majority of the membership, and which may indicate at the same time the lines along which progress may be expected in one or more branches of our favorite science. In partial recognition of the honor you have conferred upon me it has seemed that I could do no better than to consider with you some of the principal advances that have been made in mathematical science during the past century. But here at the outset one must needs feel sharply restricted by the limitations of his knowledge and by the wide extent of the domain to be surveyed. Especially must this be the case with one who belongs to no school of mathematicians, unless it be the 'old school' of inadequate opportunities and desultory training. On account of these conditions, I have found it essential to accept the ordinary division of the science into pure and applied mathematics and to confine my attention in this address wholly to applied mathematics. Here again, however, it is

* Address of the President of the American Mathematical Society, read December 28, 1899.

necessary to impose restrictions, for the domain thus divided is still far too large to be reviewed adequately in the brief interval allotted to the present occasion. I have therefore limited my considerations chiefly to those branches of applied mathematics which were already recognized as such at the beginning of the present century. The most important of these branches appear to be analytical mechanics, geodesy, dynamical astronomy, spherical or observational astronomy, the theory of elasticity, and hydromechanics. This rather arbitrary subdivision may be made to include several important branches not enumerated, while it must exclude others of equal or greater importance. Thus the theory of heat diffusion which led Fourier to the wonderful analysis which bears his name may be alluded to under physical geodesy; the theories of sound and light may be regarded as applications merely of the theories of elasticity and hydromechanics; while the theories of electricity, magnetism, and thermodynamics, which are the peculiar and perhaps most important developments of the present century, must be excluded almost altogether.

Another difficulty which besets one who would speak of the progress in question is that arising from the technicalities of the subjects to be discussed. Beautiful and important as these subjects are when arrayed in their mathematical dress, and thrilling as they truly are when rehearsed with appropriate terminology in the quiet of one's study, it must be confessed that they are on the whole rather uninviting for the purposes of semi-popular exposition. In order to meet this difficulty it seems best to relegate technicalities which demand expression in symbols to footnotes and, while freely using technical terminology, to translate it into the vernacular whenever essential. Thus it is hoped to avoid the dullness of undue condensation on the one hand, and the superficiality of mere literary description on the other.

The end of the last century marks one of the most important epochs in the history of mathematical science. This time, one hundred years ago, the master work of Lagrange (1736–1813), the Mécanique Analytique, had been published about eleven years. The first two volumes of the Mécanique Céleste of Laplace (1749–1827), undoubtedly the greatest systematic treatise ever published, had just been issued. Fourier (1768–1830), whose mathematical theory of heat was destined to play a wonderful rôle in pure and applied mathematics, was a soldier statesman in Egypt, where with Napoleon he stood before the pyramids while the centuries looked down upon them.* Gauss (1777–1855), who with Lagrange and Cauchy (1789–1857) must be ranked among the founders of modern pure mathematics, was a promising but little known student whose Disquisitiones Arithmeticae and other papers were soon to win him the directorship of the observatory at Göttingen. Poisson (1781–1840), to whom we owe in large part the beginnings of mathematical physics, had just started on his brilliant career as a student and professor in the École Polytechnique. Bessel (1784–1846), whose theories of observational astronomy and geodesy were destined soon to assume a prominence which they still hold, was an accountant in a trading house at Bremen. Dynamical astronomy, the favorite science of the day was under the dominating genius of Laplace, with no one to dispute his preëminence, and with only Lagrange and Poisson as friendly competitors in the same field. Rational mechanics as we now know it, was soon to

* The bombastic words of Bonaparte, "Songez que du haut de ces pyramides quarante siècles vous contemplent," may be excused, perhaps, in view of the fact that Fourier, Monge, and Berthollet were present on the occasion.

be simplified and systematized by Poinsot (1777–1859), Poisson, Möbius (1790–1868), and Coriolis (1792–1843), who were all at this time under twenty-five years of age. The undulatory theory of light, in which Young (1773–1829), Fresnel (1788–1827), Arago (1786–1853), and Green (1793–1841) were to be the most conspicuous early figures, was just beginning to be considered as an alternative to the emission theory of Newton. The theory of elasticity, or the theory of stress and strain as it is now called, was about to be reduced to the definiteness of formulas at the hands of Navier (1785–1836), Poisson, Cauchy, and Lamé (1795–1870). Planetary and sidereal astronomy, to which so much of talent, time, and treasure have since been devoted, was soon to receive the fruitful impetus imparted to it by the German school of Gauss, Bessel, Encke (1791–1865), and Hansen (1795–1874).

The advances that have been made during the past century in analytical mechanics must be measured from the elevated standard attained by Lagrange in his Mécanique Analytique. To work any improvement over this, to simplify its demonstrations, or to elaborate its details, was a task fit only for the keenest intellects. Lagrange had, as he supposed, reduced mechanics to pure mathematics. Geometrical reasonings and diagrammatic illustrations were triumphantly banished from this science and replaced by the systematic and unerring processes of algebra. "Ceux qui aiment l'Analyse," he says, "verront avec plaisir la Mécanique en devinir une nouvelle branche, et me sauront gré d'en avoir étendu ainsi le domaine." The mathematical world has not only accepted Lagrange's estimate of his work, but has gone further, and considers his achievement one of the most brilliant and important in the whole range of mathematical science. "The mechanics of Lagrange," as Mach has well said, "is a stupendous contribution to the economy of thought."*

Nevertheless, improvements were essential, and they came in due time. As we can now see without much difficulty, Lagrange and most of his contemporaries in their eagerness to put mechanics on a sound analytical basis overlooked to a serious extent its more important physical basis. The prevailing mathematical opinion was that a science is finished as soon as it is expressed in equations. One of the first to protest against this view was Poinsot, though the preëminent importance of the physical aspect of mechanics did not come to be adequately appreciated until the latter half of the present century. The animating idea of Poinsot was that in the study of mechanics one should be able to form a clear mental picture of the phenomena considered; and that it does not suffice to put the data and the hypotheses into the hopper of our mathematical mill and then to trust blindly to its perfection in grinding the grist. In elaborating this idea he produced two of the most important elementary treatises on mechanics of the century. These are his Éléments de Statique published in 1804, and his Théorie Nouvelle de la Rotation des Corps published in 1834.† In the former work he developed the beautiful and fruitful theory of couples and their composition, and the conditions of equilibrium, as they are now commonly expressed in elementary books.

*The Science of Mechanics, by Dr. Ernst Mach. Translated from the German by Thomas J. McCormack. Chicago, Open Court Publishing Co., 1893.

†Outlined to the Paris Academy in 1834. In the introduction to the edition of 1852 he says, "Voici une des questions qui m'ont le plus souvent occupé, et, si l'on me permet de parler ainsi, une des choses que j'ai le plus désiré de savoir en dynamique.

"Tout le monde se fait une idée claire du mouvement d'un point, * * * Mais, s'il s'agit du mouvement d'un corps de grandeur sensible et de figure quel-conque, il faut convenir qu'on ne s'en fait qu'une idée très-obscure."

In the latter he took up the more recondite question of rendering a clear account of the motion of a rigid body. This problem had been treated already by the illustrious Euler, d'Alembert, Lagrange, and Laplace, and it seemed little short of temerity to hope for any improvement. But Poinsot entertained that hope and his efforts proved surprisingly successful. His little volume of about one hundred and fifty pages is still one of the finest models of mathematical and mechanical exposition; and his repeated warning, "gardons-nous de croire qu'une science soit faite quand on l'a réduite à des formules analytiques," has been fully justified. He gave us what may be called the descriptive geometry of the kinetics of a rotating rigid body, the 'image sensible de cette rotation'; he clarified the theory of moments of inertia and principal axes; he made plain the meaning of what we now call the conservation of energy and the conservation of moment of momentum of systems which are started off impulsively; and he surpassed Laplace himself in expounding the theory of the invariable plane.

Another elementary work of prime importance in the progress of mechanics was Poisson's Traité de Mécanique. Poisson belonged to the Lagrangian school of analysts, but he was so profoundly devoted to mathematical physics that almost all his mathematical work was suggested by and directed towards practical applications. His facility and lucidity in exposition rendered all his works easy and attractive reading, and his treatise on mechanics is still one of the most instructive books on that subject. He was one of the first to call attention to the value of the principle of homogeneity in mechanics,* a principle which, as expanded in Fourier's theory of dimensions,† has proved of the greatest utility in the latter half of the century. The influence of Poisson's work in mechanics proper, very widely extended, of course, by his memoirs in all departments of mathematical physics, is seen along nearly every line of progress since the beginning of the century.

Of other works which paved the way to the present advanced state of mechanical science, it may suffice to mention the Cours de Mécanique* of Poncelet (1788–1867), the Traité de Mécanique des Corps Solides et de l'Effet des Machines† of Coriolis, and the Lehrbuch der Statik‡ of Möbius. To the two former of these authors we owe the fixation of ideas and terminology concerning the doctrine of mechanical work, while the suggestive treatise of Möbius foreshadowed a new type of mechanical concepts since cultivated by Hamilton (Sir W. R., 1805–1865). Grassmann (1809–1877), and others under the general designation of vector analysis.

Following close after the development of the elementary ideas whose history we have sketched came the important improvements in the Lagrangian analysis due to Hamilton.§ With these additions of Hamilton, amplified and clarified by the labors of Jacobi, Poisson, and others,|| analytical mechanics may be said to have reached its present degree of perfection so far as mathematical methods are concerned. By these methods every mechanical question may be stated in either of three characteristic though interconvertible ways, namely: by the equations of d'Alembert,

*See Article 23, Tome I., Traité de Mécanique, 2d ed., Paris, 1833.

† 'Théorie Analytique de la Chaleur,' Paris, 1822.

* Metz, 1826.

† Paris, 1829.

‡ Leipzig, 1837.

§ 'On a general method in dynamics.' *Philosophical Transactions*, 1834-35.

|| For an account of these additions and for a complete list of papers bearing on the subject (up to 1857), one should consult the admirable report of Cayley on 'Recent progress in dynamics,' published in the Report of the British Association for the Advancement of Science for 1857.

by the equations of Lagrange, and by the equation of Hamilton. Each way has special advantages for particular applications, and together they may be said to condense into the narrow space of a few printed lines the net results of more than twenty centuries of effort in the formulation of the phenomena of matter and motion.

Such was the state of mechanical science when the great physical discovery of the century, the law of conservation of energy, was made. To give adequate expression to this law it was only necessary to recur to the Mécanique Analytique, for herein Lagrange had prepared almost all of the needful machinery. So well indeed were the ideas and methods of Lagrange adapted to this purpose that they have not only furnished the points of departure for many of the most important discoveries* of the present half century, but they have also supplied the criteria by means of which mechanical phenomena in general are most easily and effectively defined and interpreted.

Of the special branches of analytical mechanics which have undergone development during this century, by far the most important is that known as the theory of the potential function. This function first appeared in mathematical analysis in a memoir of Lagrange in 1777 † as the expression of the perturbative function, or force function. It next appeared in 1782 ‡ in a memoir by Laplace. In this memoir Laplace's equation § appears for the first time, being here expressed in polar coördinates. In 1787* the same equation appears in the more usual form as expressed by rectangular coördinates.

Strange as it now seems when viewed by the light of this end of the century, nearly thirty years elapsed before Laplace's equation was generalized. Laplace had found only half of the truth, namely, that which applies to points external to the attracting masses.† Poisson discovered the other half in 1813.‡ Thus the honors attached to the introduction of this remarkable theorem are divided between them, and we now speak of the equation of Laplace and the equation of Poisson, though the equation of Poisson includes that of Laplace.

Next came the splendid contributions of George Green under the modest title of "An essay on the application of mathematical analysis to the theories of electricity and magnetism."§ It is in this essay that the term 'potential function' first occurs. Herein also his remarkable theorem in pure mathematics, since universally known as Green's theorem, and probably the most important instrument of investigation in the whole range of mathematical physics, made its appearance.

We are all now able to understand, in a general way at least, the importance of Green's work, and the progress made since the publication of his essay in 1828. But fully to appreciate his work and subsequent progress, one needs to know the outlook for the mathematico-physical sciences as it appeared to Green at this time, and to realize his refined sensitiveness in promulgating his discoveries.

*Especially those in the theories of electricity, magnetism, and thermodynamics.

† *Nouveaux Mémoires de l'Académie des Sciences et Belles Lettres de Berlin.* See also remarks of Heine, Handbuch der Kugelfunctionen, Band II., p. 342.

‡ *Paris Memoires* for 1782, published in 1785.

§ $$\Delta^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0.$$

$\Delta^2 V$ is called the Laplacian of V.

* *Paris Memoires* for 1787, published in 1789.

† That is, Laplace's equation is $\Delta^2 V = 0$, while Poisson's is $\Delta^2 V + 4\pi k\rho = 0$, V being the potential and ρ the density at the point (x, y, z), and k being the gravitation constant.

‡ Poisson's equation was derived in a paper published in *Nouveau Bulletin * * * Société Philomatique*, Paris, Dec., 1813.

§ Nottingham, 1828.

"It must certainly be regarded as a pleasing prospect to analysts," he says in his preface, "that at a time when astronomy from the state of perfection to which it has attained, leaves little room for further applications of their art, the rest of the physical sciences should show themselves daily more and more willing to submit to it. * * * Should the present essay tend in any way to facilitate the application of analysis to one of the most interesting of the physical sciences, the author will deem himself amply repaid for any labor he may have bestowed upon it; and it is hoped the difficulty of the subject will incline mathematicians to read this work with indulgence, more particularly when they are informed that it was written by a young man, who has been obliged to obtain the little knowledge he possesses, at such intervals and by such means, as other indispensable avocations which offer but few opportunities of mental improvement, afforded." Where in the history of science have we a finer instance of that sort of modesty which springs from a knowledge of things?

The completion of the potential theory, so far as it depends on the Newtonian law of the inverse square of the distance, must be credited to Gauss, though a host of writers has since contributed many valuable additions in the way of details. Early in the century Gauss had begun the study of the absorbing problems of the day, namely, problems of attractions and repulsions. The prevailing notion of mathematical physicists seems to have been that all mechanical phenomena may be attributed to attractions and repulsions between the ultimate particles of matter and the ultimate particles of 'fluids' associated with matter. The difficulties of action at a distance, without the aid of an intervening medium, happily, did not trouble them at that time; for who shall say that their labors would have been more fruitful if they had stopped to remove these difficulties? Gauss's first memoir in this field relates to the attractions of homogeneous ellipsoidal masses,* and dates from 1813. It was in this memoir that he published a number of the elegant theorems † which are now found in the elementary books on the theory of the potential function. In 1829 he published his theory of fluid figures in equilibrium,‡ and in 1832 there followed one of the most important papers of the century on the intensity of terrestrial magnetic force expressed in what we now call absolute units. § Six years later he published his wonderful theory of the earth's magnetism || and applied it to all existing observational data. This theory is a splendid application of the potential theory, and his entire investigation is one of the most beautiful and useful contributions to mathematical physics of the century. Well was he qualified, therefore, to complete the theory of the Newtonian potential function in the collection of theorems published in his memoir ¶ of

* 'Theoria attractionis corporum sphaeroidicorum ellipticorum homogeneorum,' 1813. See Gauss's Werke, Band V., Göttingen, 1877.

† Especially the theorem giving the values of the surface integral

$$\int \frac{\cos (s, n)}{s^2} dS,$$

where dS is an element of any closed surface, s the distance from dS to any fixed point, and n indicates the normal to the surface at dS. This gave the key to the very important theorem of the surface integral of the normal acceleration, or

$$\int \frac{\partial V}{\partial n} dS.$$

‡ 'Principia generalia theoriæ figuræ fluidorum in statu æquilibrii,' 1829. Werke, Band V.

§ 'Intensitas vis magneticæ terrestris ad mensuram absolutam revocata.' Werke, Band V.

|| Allegemine Theorie des Erdmagnetismus. Werke, Band V.

¶ 'Allegemine Lehrsätze in Beziehung auf die im verkehrten Verhältnisse das Quadrats der Entfernung wirkenden Anziehungs- und Abstossungs-Kräfte.' Werke, Band V.

1840. This is still the fundamental memoir on the subject of which it treats, and must be regarded as one of the most perfect models of mathematical exposition. In respect to clearness and elegance, indeed, the works of Gauss are unsurpassed. "In his hands," as Todhunter has said,* "Latin and German rival French itself for clearness and precision." "Alles gestaltet sich neu unter seinen Händen," was the tribute † of Bessel; and the lapse of two generations has served only to increase admiration for the genius and industry which made Gauss one of the most conspicuous figures in the science of the nineteenth century.

The importance of the theory of the potential function when considered in its historical aspects is found to consist not so much in the rich harvest of results it has afforded in the field of gravitation, as in its direct bearing on the developments of other branches of mathematical physics. For the points of view and the analytical methods of the Newtonian function have been adapted and extended with brilliant success to the interpretation of almost all kinds of mechanical phenomena. Thus it has come about that we have now to deal with many kinds of potential, as logarithmic potential, velocity potential, displacement potential, electric potential, magnetic potential, thermodynamic potential, etc., each of which bears a more or less close mathematical analogy to the Newtonian function.

In the closing paragraph of his Exposition du Système du Monde, Laplace refers to the immense progress made in astronomy since the geocentric theory was displaced by the heliocentric theory of the solar system. This progress is specially remarkable when we consider that it depended on the discovery, so humiliating to man, of the relatively insignificant dimensions and inconspicuous rôle of our planet. But we agree with Laplace that "Les resultats sublimes auxquels cette découverte l'a conduit sont bien propres à le consoler du rang qu'elle assigne à la Terre, en lui montrant sa propre grandeur dans l'extrême petitesse de la base qui lui a servi pour mesurer les cieux." All astronomy is based on a knowledge of the size, the shape and the mechanical properties of the earth; and it is not surprising, therefore, that a large share of the mathematical investigations of the century should have been directed to the science of geodesy. Founded in the middle of the last century by Clairaut* and his contemporaries; recast by Laplace and Legendre † (1752–1833) in the early part of this century; systematized and extended to a remarkable degree by the German geodesists, led especially by the incomparable Bessel;‡ this science has now come to occupy the leading position in point of perfection of methods and precision of results. So great, in fact, has been the growth of this science during the century that recent writers have found it desirable to subdivide the subject into two parts called mathematical geodesy and physical geodesy respectively, though both parts are nothing if not mathematical.§

In a former address I have considered somewhat in detail certain of the more

* History of the Theories of Attraction and Figure of the Earth, Vol. II., p. 235.

† In a letter to Olbers, 1818.

* Clairaut's work, Théorie de la Figure de la Terre, Paris, 1743, was the pioneer work in physical geodesy.

† The name of Legendre is famous in geodesy by reason of his beautiful theorem which makes the solution of a geodetic triangle almost as easy as the solution of a plane triangle.

‡ Bessel's contributions to astronomy and geodesy are collected in Abhandlungen von F. W. Bessel, herausgegeben von Rudolf Engelmann, in drei Bänden, Leipzig, Wilhelm Engelmann, 1875.

§ See, for example, Die Mathematischen und Physikalischen Theorieen der Höheren Geodäsie von Dr. F. R. Helmert, Leipzig, B. G. Teubner, Teil I., 1880; Teil II., 1884.

salient mathematical problems which have arisen in the study of the earth;* and the present review may hence be restricted to a rapid résumé of the less salient but perhaps more recondite problems, and to the briefest mention of problems already discussed.

Adopting the convenient nomenclature of geologists, we may consider the earth as made up of four parts, namely, the atmosphere; the hydrosphere, the oceans; the lithosphere, or crust, and the nucleus. Beginning with the first of these we are at once struck by the fact that much greater progress has been made during the century in the investigation of the kinetic phenomena of the atmosphere than in the study of what may be called its static properties. Evidently, of course, the phenomena of meteorology are essentially kinetic, but it would seem that the questions of pressure, temperature and mass distribution of the atmosphere ought to be determined with a close approximation from purely statical considerations. This appears to have been the view of Laplace, who was the first to bring adequate knowledge to bear upon such questions. He investigated the terrestrial atmosphere as one might investigate the gaseous envelope of an unilluminated planet.† He reached the conclusion that the atmosphere is limited by a lenticular-shaped surface of revolution whose polar and equatorial diameters are about 4.4 and 6.6 times the diameter of the earth respectively, and whose volume is about 155 times that of the earth.‡ If this conclusion be true our atmosphere should reach out to a distance of about 26,000 miles at the equator and to a distance of about 17,000 miles at the poles. It does not appear, however, that Laplace attempted to assign the distribution of pressure and density, and hence total mass of the atmosphere within this envelope; and I am not aware that any subsequent investigator has published a satisfactory solution of this apparently simple problem.*

*On the Mathematical Theories of the Earth. Vice-presidential address before Section of Astronomy and Mathematics of the American Association for the Advancement of Science, 1889. *Proceedings of A. A. A. S.*, for 1889.

† Mécanique Céleste, Livre III., Chap. VII., and Livre X., Chapts. I.–IV.

‡ Laplace's equation to a meridian section of this envelope is

$$x^{-1} - x_0^{-1} + \tfrac{1}{2}ax^2\cos^2\phi = 0,$$

where $x = r/a$, r being the radius vector measured from the center of the earth and a the mean radius of the earth; a is the ratio of centrifugal to gravitational acceleration at the equator of the earth; ϕ is geocentric latitude, and x_0 is the value of x for $\phi = \pi/2$.

The problem of the statical properties of the atmosphere may be stated in three equations, namely:

$$\Delta^2 V + 4\pi k\rho - 2\omega^2 = 0,$$
$$dp = \rho dV,$$
$$p = f(\rho, \tau).$$

In these V is the potential at any point of the atmosphere; p, ρ, τ being the pressure, density and temperature at the same point; k is the gravitation constant; and ω is the angular velocity of the earth. The above equation of Laplace neglects the mass of the atmosphere in comparison with the mass of the rest of the earth. An essential difficulty of the problem lies in the unknown form of the function $f(\rho, \tau)$.

*I have sought a solution with a view especially to determine the mass of atmosphere. A class of solutions satisfying the mechanical conditions of the following assumptions has been worked out. Thus, assuming $p = c\rho^m$, which includes the adiabatic relation, $p = c\rho^{1.41}$, and the famous Laplacian relation, $\partial p/\partial\rho = 2c\rho$; and the law of Charles and Gay-Lussac, $p = C\rho\tau$; there results

$$\frac{p}{p_0} = \left(\frac{Q}{Q_0}\right)^{\frac{m}{m-1}}, \quad \frac{\rho}{\rho_0} = \left(\frac{Q}{Q_0}\right)^{\frac{1}{m-1}}, \quad \frac{\tau}{\tau_0} = \frac{Q}{Q_0},$$

where $Q = x^{-1} - x_0^{-1} + \tfrac{1}{2}ax^2\cos^2\varphi$

defined above; Q_0 is the value of Q for $x = 1$ and $\phi = \pi/2$; and p_0, ρ_0, τ_0 are the values of p, ρ, τ at the same point $(x = 1, \phi = \pi/2)$.

Using the adiabatic law the above formula for ρ leads to a mass for the atmosphere of about 1/1200th of the entire mass of the earth. But since the adiabatic law gives too low a pressure, density and temperature gradient, this can only be regarded as an upper limit to the mass of the atmosphere. A lower limit of about 1/1000000th of the earth's mass is found by assuming that the mass of the atmosphere is equal to the mass of water or mercury which would give an equivalent pressure at the earth's surface.

On the other hand, the general character of the circulation of the atmosphere and the meteorological consequences thereof, have been brought within the domain of mathematical research, if they have not yet been wholly reduced to quantitative precision. The pioneer in this work was a fellow-countryman, William Ferrel (1817–1891),* who, like Green, came near being lost to science through the obscurity of his early environment. It is a curious though lamentable circumstance, illustrating at once the peculiar shyness of Ferrel and the proverbial popular indifference to discoveries which cannot be patented, that a man who had mastered the Principia and the Mécanique Céleste and who had laid the foundation of our theory of the circulation of the atmosphere, should have found no better medium for the publication of his researches than the semi-popular columns of a journal devoted to medicine and surgery. But such was the medium through which Ferrel's 'Essay on the Winds and Currents of the Ocean' appeared † in 1856. Since that time notable progress has been made at the hands of Ferrel, Helmholtz (1821–1894), Oberbeck, Bezold and others ;‡ so that we may entertain the hope that the apparently erratic phenomena of the weather will presently yield to mathematical expression, just as the similar phenomena of oceanic tides and terrestrial magnetism have already yielded to the power of harmonic analysis.

* For a biography and autobiographical sketch of Ferrel, and a list of his publications, see Biographical Memoirs of the National Academy of Sciences, Vol. III., pp. 265–309. Washington, 1895.

† In *Nashville Journal of Medicine and Surgery*, Oct. and Nov., 1856.

‡ Some of the most important papers and memoirs on this subject, collected and translated by Professor Cleveland Abbe, have been published by the Smithsonian Institution under the title 'The Mechanics of the Atmosphere.' Smithsonian Miscellaneous Collections, No. 843, Washington, 1891.

When we pass from the atmosphere to the hydrosphere, several questions concerning the nature and properties of their common surface, or what is usually called the sea surface, immediately demand attention. The most important of these are what may be distinguished as the static and the kinetic phenomena of the sea surface. Since tidal oscillations belong more properly to hydrokinetics, we may here confine attention to the static phenomena.

Starting from the datum plane fixed by Laplace, the most important contribution to the theory of physical geodesy since his time is the remarkable memoir of Sir George Gabriel Stokes 'On the Variation of Gravity at the Surface of the Earth.'* Adopting the hypothesis of original fluidity, or the more general hypothesis of a symmetrical arrangement of the strata of the earth, with increasing density towards the center, Laplace had shown that the acceleration of gravity in passing from the equator to the poles should increase as the square of the sine of the latitude.† This conclusion agreed well with the facts of observation; and Laplace rested content in the opinion that his hypothesis was verified. But Stokes showed that the law of variation of the acceleration of gravity at the surface of the sea is wholly determined by that surface, regardless of the mode of distribution of the earth's mass. This, as we now see, of course, is a direct result of the theory of the potential function; for the sea surface is an equipotential surface, and since it is observed to be closely spheroidal, the formula of Laplace follows independently of all hypothesis save that of the law of gravitation. But while Laplace's formula

* Read April, 1849. See Mathematical and Physical Papers by G. G. Stokes, Cambridge University Press, 1883, Vol. II.

† Laplace's formula is $g = \alpha + \beta \sin^2\phi$, where α is the value of g at the equator, β is a constant, and ϕ is the latitude of the place.

and the arguments by which he reached it throw no light on the distribution of the earth's mass, a slight extension of his methods gives a formula which shows that any considerable difference in the equatorial moments of inertia of the earth would produce a variation in the acceleration of gravity dependent on the longitude of the place of observation.* Thus it is possible by means of pendulum observations alone to reach the conclusion that the mass of the earth is very nearly symmetrically distributed with respect to its equator and with respect to its axis of revolution.

A question of great interest with which the acceleration of gravity at the sea surface is closely connected is that of the earth's mass as a whole. About two years ago I published a short paper which gives the product of the mean density of the earth and the gravitation constant in terms of the coefficients of Laplace's formula and the dimensions of the earth.† It was shown that this product can be easily computed from existing data to five significant figures with an uncertainty of only one or two units in the last figure; thus making it possible to obtain the mass of the earth to a like degree of precision if the constant of gravitation can be equally well determined. In a subsequent communication to this Society it was explained that the product in question is equal to 3π divided by the square of the periodic time of an infinitesimal satellite which would pass around the earth just grazing the equator if there were no atmosphere to impede its progress. The periodic time of such a satellite would be 1 hour, 24 minutes, 20.9 seconds. Attention is called to this subject with the hope that some mathematician may point out another possible relation between the gravitation constant and the mean density of the earth which can be accurately observed, or that some physicist may show how the gravitation constant can be measured directly with a precision extending to five significant figures.

The lithosphere is the special province of the geologist, and we may hence pass on to the nucleus, or chief part of the mass of the earth. Much time and attention have been devoted to the study of the important but intricate problems which the geometers of the early part of the century left to their successors. But while the obscurities and vagaries of our predecessors have been cleared away, it must be confessed that our improved mathematical apparatus has not brought us very far ahead of the positions of Laplace and Fourier as regards the constitution and properties of the nucleus. With respect to the law of the distribution of density in the nucleus it may be said that although Laplace's law* is probably not ex-

* See Helmert, Geodäsie, Band II., p. 74. The expression for the acceleration is

$$g = \alpha + \beta \sin^2 \phi + \gamma \cos^2 \phi \cos 2\lambda,$$

where α, β, γ are constants, and ϕ, λ are latitude and longitude respectively; and the constant γ involves the difference of the equatorial moments of inertia as a factor.

† See *The Astronomical Journal*, No. 424. This product is expressed thus:

$$k\rho = \frac{2\pi}{T^2} + \frac{3(\alpha s_1 + \beta s_2)}{4\pi a \sqrt{1 - e^2}};$$

wherein k is the gravitation constant, ρ is the mean density of the earth, T is the number of mean solor seconds in a sidereal day, α and β are the first two constants in the formula $g = \alpha + \beta \sin^2 \phi + \gamma \cos^2 \phi \cos 2\lambda$ for the acceleration of gravity at the sea surface in latitude φ and longitude λ; a is the half major axis and e is the eccentricity of the earth's spheroid; and

$$s_1 = \frac{1}{2}\left\{1 + \frac{1 - e^2}{2e} \log \frac{1 + e}{1 - e}\right\},$$

$$s_2 = \frac{1 - e^2}{4e^2}\left\{\frac{2e}{1 - e^2} + \log \frac{1 - e}{1 + e}\right\}.$$

The resulting numerical value is

$$k\rho = 36797 \times 10^{-11}/(\text{second})^2.$$

* The Laplacian distribution of pressure, density, and potential in the earth are defined essentially (neglecting the effect of rotation) by the three following equations:

act it is yet quite as nearly correct as our observed information requires.*

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(*To be concluded.*)

THE POSITION THAT UNIVERSITIES SHOULD TAKE IN REGARD TO INVESTIGATION.†

WHAT position shall universities take with regard to investigation? When the honor was done me of asking me to take part in this discussion, my first thought, after the sensation of complacency at the compliment, was that there could hardly be a *discussion* where all held probably very nearly the same views, and that the great difficulty would be to say anything that would not be better said by another. Then as I began to think more carefully, I saw that the question was not, as I had at first imagined it to be, "what shall universities do to encourage those on their staffs to investigate?" It is far wider than that. It comprises a whole group of questions concerning which there may be every shade of opinion. So the more I thought, the more I admired the wisdom the committee had shown in their choice of a subject. Later still, it dawned upon me that surely it is a most satisfactory sign of progress that this Society should meet to discuss such a subject, with the conviction that, though without the shadow of a legal right to make claims, we are, nevertheless, sure of a sympathetic hearing from both universities and the public.

First of all let us consider the place of investigation in education, as a means of mental training, quite apart from any definite results. Surely this alone opens a wide field for one afternoon's ramble, in which there are diverging and recrossing paths enough to furnish us the surprises of unexpected partings and unhoped-for reunions.

I would here remark that perhaps some confusion is possible from different interpretations of the word 'investigation.' According to some it means simply practical work, object teaching, or, better still, object study. According to others it is the search for something new. With regard to the value of the former we are all pretty well agreed. We do not need to be told what an advance it is over the old way of learning the statements of others concerning matters well within the sphere of observation. It may sometimes be carried too far, but in view of its great usefulness we will not quarrel with a little abuse. With what is meant by the second interpretation the case is different. Excepting some singularly gifted natures, it does not, in my opinion, concern the student. The universal or even the very general application of this method is the result of an extreme reaction. It rests on a fallacy. Because investigation is a good thing, and worthy of encouragement, which all must admit, it is assumed to be good for all, and an accepted method of education, which conclusion I cannot adopt. It is for the beginner to learn what is worth learning in his particular field first of all. It is not easy in these days to learn all that is worth learning even in a very restricted department. To start on investigation with this only half-learned is a direct

$$\Delta^2 V + 4\pi k\rho = 0,$$
$$dp = \rho\, dV,$$
$$\frac{\partial p}{\partial \rho} = c\rho\,;$$

where p, ρ, V are the pressure, density, and potential at any point of the mass, k is the gravitation constant, and c is a constant securing the equality of the members of the last equation.

* With regard to what constitutes an adequate theory in any case, see an instructive paper by Dr. G. Johnstone Stoney on 'The kinetic theory of gas, regarded as illustrating nature.' *Proceedings, Royal Dublin Society*, Vol. VIII. (N. S.), Part IV., No. 45.

† Discussion before the American Society of Naturalists at the New Haven Meeting, December 25, 1899

injury to the student, whom it turns to premature specialization. It is both foolish and cruel to exact investigation as a part of the regular training of every student, and very unjust to imply that those whose taste does not lie that way are mentally inferior to those who dabble in research, no matter how ineffectively. It may be replied that, granting this, still it is a good and necessary training for those who in after life are to become investigators. I incline to dissent still, for the born investigator (and no other is worth much trouble) no more needs encouragement to investigate than the fish does to swim. I would, if anything, restrain him till his education has become broad and his mind mature. He will very quickly more than make up the lost time. Then let him have every encouragement.

As regards education I speak as a professor in a medical school, whose career has been so placed that he has seen this school develop into a department of a university. I feel that, in common with others, it has reached a point when it is in danger from the side of its scientific friends who mistake or will not learn the true purpose of a medical school. I so rarely find myself in complete accord with Huxley, that I cannot forbear, though it is not for the first time, quoting his deliberate opinion, that whoever adds one tittle that is unnecessary to medical education is guilty of a very grave offense. If this be true, as I firmly believe it is, we must look to it that the candidate for the degree of M.D. be not robbed of his time, none too long for learning medicine as an art, by specially conducted excursions into abstract science. It may be said, and said truly, that without such auxiliaries the education of the student wants something of the breadth which his should have who aspires to stand on the pinnacle; but this only emphasizes the fact, now becoming daily clearer, that there has grown up the need of what may be called advanced medicine. Some would have this strictly post-graduate, but it is probably wiser to have a difference in the course. On the one hand there is the young man who aspires to be a conscientious every-day practitioner of medicine, looking forward to a life of hard work among suffering humanity. Such a one is not to be refused the degree of an honored university, and told superciliously to go to the little school round the corner. Neither is he who, looking at the matter more as a scholar, desires through his studies to train himself to teach others and to widen the horizon of knowledge, to be told that we have no help to offer to one of his ideals. We must provide for both; but with what power I have I shall always protest against sacrificing the first to the second, though the latter is the one with whom my tastes incline me to sympathize.

To sum up thus far, I conclude that it is not the duty of universities to urge, still less to force, original investigation upon students. It should be at hand for those whose zeal is so great that it will take no denial.

The next question is what universities should do for research in the community at large. Are more prizes and scholarships to be offered? As to prizes I should hesitate to say yes. It is not well that they should be too common; but of scholarships for deserving men we can hardly have too many. It is most desirable that the universities should award them. They cannot, indeed, give the funds, but, these being provided, committees from the universities should give their time, care and experience to their proper administration. This is a most beneficent and dignified attitude for a university, midway between the generous donor and the deserving student, to see that the generosity of the former is neither neglected nor abused.

The next and last aspect of the question that I shall consider is "what shall a university do for the support and encouragement of investigators within its walls?" The primary function, in my opinion, of a professor is to teach; but, with certain exceptions of rare merit, it is necessary for his reputation and influence that he should do original work. The first duty of the university to him is that he should not be overburdened with teaching. The next problem is, how the expenses of his work are to be met. These must vary with the department. For some lines of research distant expeditions are requisite, necessarily so costly that they can hardly be provided for otherwise than by national or private munificence. But putting these aside, and speaking more particularly of biological and morphological work, the problem reduces itself to this: what help shall the university give to the investigator, (1) in the matter of providing the material, namely, the subject matter for the study, (2) the machinery and reagents for the work, (3) the means of illustrating it, and finally of publishing the paper. The last need is not urgent on account of the great number of journals of all kinds, but it exists in isolated cases. Till comparatively recently the position of universities has been much like that of the Pickwick Club, which when sending its honored founder and his companions on their travels saw no objection to every member paying his own bills. But professors for the most part suffer from 'that perpetual lack of pence which vexes public men,' and those who are not yet professors are, of course, vexed the more. Is it fair that a serious tax, ever increasing in direct ratio to his merit, should be laid on the investigator, especially as the university profits in no small degree by his success? I am sure we shall all agree it is not. But then difficulties present themselves as to how this help is to be given and distributed, assuming that the university admits the claim. Who are to be the chief beneficiaries? The most distinguished or the most needy? The oldest because of his years? Or the youngest because of his youth? And again is it just that the university should furnish large sums for bringing out papers of unknown merit? It seems to me that the most feasible way, if the money can be procured, is to place a sum in the hands of the professor at the head of each scientific department, to be spent for the good of that department, including publication, according to his discretion, or his lack of it. Should the latter be painfully apparent, the resulting unpopularity will surely be irresistible, and thus there will be a check on a system which may at first seem too arbitrary.

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THE primary function of a university is the diffusion of knowledge, and it is, I believe, equally true that these higher institutions of learning are in great part responsible for the extent to which knowledge is spread throughout the land. Before there can be diffusion of knowledge, however, there must be acquisition of knowledge, and we may at once ask the question, how far shall the university lend its aid in the encouragement of scientific research with a view to the enlargement of the boundaries of human knowledge? It is obvious that the force and energy of a great university must of necessity be given to the training of its students in the various departments of study laid down in the curriculum, and a university worthy of the name certainly cannot afford to devote the major part of its energies to the pursuit of scientific research, neither in my judgment would it be justified in so doing. By such a procedure, it would forfeit the right to the name of university, and its power for usefulness would be curtailed in no small measure

It is clear that loss in one direction might be counterbalanced by gain in another, but the true university must ever remain a place where the student can obtain knowledge of past discoveries, and of the sciences based thereon, together with that broad training which helps to make the educated man. In other words, the university cannot escape from its responsibility as an educational center for the diffusion of knowledge, and any attempt to transform the university into an institution for research alone would be detrimental to the best interests of higher education.

Shall the university, on the other hand, limit itself to routine instruction? To this there can be but one answer, and that is most emphatically, no. The true teacher of science, for example, must ever be a student, not only familiar with the past, but ever on the alert to interpret such signs as nature may make, quick to seize the opportunity to add to man's knowledge, to broaden and extend the limits of his chosen science, to keep in touch with the advances of the present and to harmonize these advances with the knowledge of the past, bearing clearly in mind that whatever is gained by scientific inquiry or research is never lost. As Sir Michael Foster has well said in a recent address, "what is gained by scientific inquiry is gained forever; it may be added to, it may seem to be covered up, but it can never be taken away."

The teacher of science who is content to devote himself entirely to the exposition of that which is known will never make an ideal teacher. He can never hope to arouse that enthusiasm among his students which comes from the man who adds to his power of teaching that love for his science and its advancement which prompts to steady, courageous application in the unravelling of nature's secrets. This influence for good upon the man himself is not to be overlooked, for I take it that the university has a selfish interest, if no other, in the intellectual development and advancement of the teacher who presides over this or that department of science. The pursuit of scientific inquiry, under proper conditions, tends to the development of moral courage and steadfast endurance; it is a school of discipline which leads to the acquisition of strength and power, which helps to make a man master of himself and at the same time obedient to nature's ways. As Professor Foster has said, men of science, though in themselves no stronger or better than other men, "possess a strength which is not their own, but is that of the science whose servants they are. Even in his apprenticeship the scientific inquirer, while learning what has been done before his time, if he learns it aright, so learns it that what is known may serve him not only as a vantage ground whence to push off into the unknown, but also as a compass to guide him in his course. And when fitted for his work he enters on inquiry itself, what a zealous, anxious guide, what a strict, and, because strict, helpful schoolmistress does nature make herself to him! Under her care every inquiry, whether it bring the inquirer to a happy issue or seem to end in nought, trains him for the next effort. She so orders her ways that each act of obedience to her makes the next act easier for him, and step by step she leads him on toward that perfect obedience which is complete mastery. Indeed, when we reflect on the potency of the discipline of scientific inquiry, we cease to wonder at the progress of scientific knowledge."

May we not, therefore, claim, from this standpoint alone, that the university should look with favorable eye upon scientific investigation within its boundaries, since its encouragement must lead to the development of strength and power in its teachers? Indeed, may we not urge that this recognition of the indirect advantages of scientific research to the university should give way to direct and positive encouragement, an encouragement which should manifest itself in such an allotment of routine duties as would afford a reasonable amount of time for research to all suitable teachers in the university? I say *suitable* teachers, and, speaking as a physiologist, I should like to raise the question, whether the teacher of an experimental science, like physiology, if he is truly a suitable teacher, must not be an investigator also. Do not the two of necessity go together? And must not the university, if at all zealous for the character of the instruction offered within its walls, see to it that its teachers of science are not merely adepts at expounding that which is known, but are equally ambitious to open up new paths of knowledge in their respective departments of science?

Another, and more direct, reason why the university should encourage and aid scientific investigation is that by so doing it enlarges its own scope of usefulness as an educational center. The modern university, if it is to fulfill its purpose as an educational institution, must be well equipped with laboratories and those other facilities which go to make the teaching of an experimental science a success. What would the teaching of physiology and physiological chemistry, even in elementary form, amount to without the aid of laboratory facilities? The university, whether it looks with a favoring eye upon investigation or not, must have ample appliances for the teaching of the experimental sciences, and the more complete the equipment the better adapted is the university for carrying on its legitimate work. Moreover, the university of to-day is called upon to provide instruction for more advanced students; men and women who are themselves looking forward to the possibility of becoming teachers, who are anxious to learn the methods of scientific work, and who are desirous of demonstrating for themselves experimentally the facts upon which the important theories and hypotheses of their chosen science depend. For the realization of proper instruction in these respects, the university must provide suitable equipment if it is to live up to its high privileges, as well as have a suitable corps of instructors capable of leading on such advanced workers. The university must, therefore, have at hand all those appliances which are essential for research or investigation, and which the individual worker can rarely afford. Why should not these be utilized by competent investigators for scientific research? Fine laboratories and fine apparatus are of value only so far as they contribute to the spread of knowledge, and if they can be utilized for the acquisition of new facts, so much greater will be their usefulness, and so much more credit to the university that renders them available. But, having the appliances, should not the university make strenuous efforts even to encourage research; not passive encouragement, but direct, positive encouragement, that will not rest until the laboratory is filled with earnest workers taking advantage of the various facilities provided? I think, yes, and it takes very little imagination to picture the direct and indirect advantages accruing both to the university and to science by the fulfillment of such a suggestion.

Contrast, as you easily can, the difference in the atmosphere between a physiological laboratory, for example, occupied solely by a class at stated intervals on certain days of the week, and the laboratory in which zealous workers are to be found, ever experimenting on new problems, spurred on continuously by the stimulating influence of new facts and new observations, making a rallying place for the earnest thinkers and workers who constitute an ever-present example for the elementary workers in the science. Who can measure the influence for good which emanates from such a laboratory? Does not the university derive, both directly and indirectly, an inestimable advantage from such surroundings, and may we not justly claim that the university by such encouragement of research adds directly to its own power and strength, while at the same time aiding in the advancement of the science? Its scope of usefulness is thereby greatly enlarged; advanced workers in the science are attracted to the university, and even the routine instruction given to the various classes, both graduate and undergraduate, is influenced by the atmosphere of earnest endeavor which permeates the laboratory. The tone of the institution is raised, while both student and instructor feel the stimulating effects of that environment which permits the carrying out of successful scientific work.

Granting all this, the question may be asked, how *far* is it allowable for the university to extend aid in the encouragement of research? It seems to me that the answer to this question must depend upon the resources of the individual institutions. The university must be true to the primary object of its existence. It cannot overlook the fact that it was created for a specific purpose, and the fulfillment of that purpose must be its first care. All higher institutions of learning, however, are bound to recognize the necessity of providing means for the carrying on of original investigations in the various branches of science. I believe, as a rule, it is better for our scientific workers to be connected with the university, than to carry on their work in connection with a special research laboratory, with complete freedom from academic duties. I think higher education would suffer if research work was limited to special research laboratories, and the advancement of science would not be as rapid as under existing conditions, where the research worker must spend a portion of his time in careful retrospect. Just as work in investigation helps to make a better teacher, so, in my judgment, the necessity of giving instruction to a body of young workers helps to make a better investigator. It should be the duty of the university, however, so far as possible, to allow time and provide means for investigation, and by the aid of scholarships and fellowships, judiciously awarded, offer inducements for the younger workers to spend a portion of their time in scientific research.

Do not the results which have been obtained by scientific workers in connection with our own and foreign universities afford ample proof of the value of this method of encouraging investigation and advancing scientific knowledge? Consider, if you will, the results which have been attained during the last twenty years in physiology; the advancement made along so many lines and in so many different directions, and then glance at the names of the men who have carried out these investigations and note their positions in life. They are practically all university men; men who have carried on research work in connection with their academic duties, in some cases unaided, but frequently with the coöperation of younger workers, assistants, fellows, etc., to whom they have taught in this way the methods of scientific investigation. I have just received the Jahresbericht für Thierchemie for 1898, containing the record of investigation for that year in physiological chemistry. The book contains 850 pages filled with brief abstracts of the researches in this somewhat narrow field of investigation. Does not this record indicate that investigation is being encouraged? That the universities and other institutions of learning are consciously or unconsciously taking a position of helpfulness toward scientific research? I believe this to be the case, and while we must admit that in this country there is not quite the same liberality as exists abroad, yet I believe that all of our more prominent institutions of learning are willing and anxious, so far as their means will allow, to foster the spirit of investigation, both for the personal advantage to be derived therefrom, and for the sake of advancing the knowledge of science in its various departments. Certainly, the university cannot afford to take any position other than that of helpfulness towards scientific research, or manifest any disposition other than one of coöperation in the attempts that are made to advance the boundaries of human knowledge.

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EDUCATION as a preparation for conduct involves a fitting in respect to the two all-important factors by which conduct is determined. The educated man differentiates himself from the uneducated by the greater range and variety and by the intrinsic character of the influences to which he is responsive, and again by his mode of response to these influences and to the ordinary and extraordinary events and situations which our common environment presents. The receptive side of education is the more tangible and therefore apt to absorb attention beyond its due. It is so obviously important—especially in days like these, when there is such an endless series of things which it is necessary and useful to know—to furnish the individual with the maximum opportunities of acquiring information, that the problem that is apt to be relatively neglected is that of fitting him to use what he acquires, of making his stock of knowledge not a burden to be carried, but part of the strength that carries.

In the realm of education action and reaction are not necessarily equal; the individual may be exposed to wholesome and inspiring influences and yet derive from them neither health nor strength. A thorough education includes a training in both action and reaction; it educates one to be widely and deeply and yet critically receptive, to be judiciously and ably and yet creatively expressive. From the first to the last it considers both these aspects; feeling and knowing, observing and assimilating must step by step be complemented by doing and experimenting, by coördinating and originating. However true that the response presupposes the stimulus, yet the latter alone in the complicated conditions here pertinent will not produce it; it requires a strengthening of the reaction impulse, a guidance of the executive capacities.

To indicate the application of this principle to the elementary and intermediate phases of education is no part of the present discussion; and yet it may be in place to record my conviction that the furtherance of the responsive and originative functions in these stages of education is itself an important aid to the proper recognition of the place of investigation in the university. If from kindergarten to common school, and from these to high school and college, coördinative thinking could be successfully taught, if each step of knowledge could be made to yield an increase in the capacity to handle and arrange one's thoughts, then the necessity of keeping aglow the flames thus kindled, of laying stress upon originality and achievement in the university would more easily gain due recognition.

It is apparent that I claim as an important function of investigative work in the university its directive influence upon collegiate and university studies; and the recognition of this function on the part of the university authorities must always be a prominent motive for the proper provision of opportunities for investigation. From whatever other points of view it may be or become the duty of the leading institutions of learning to contribute to the advancement of the boundaries of knowledge, the pedagogical motive will never lose its pertinence. But whether for the strengthening of its internal educational structure, or as a proper expansion of the university sphere of influence, there will always remain a close community of method and interest in all provision for research. That community is the furtherance of the investigative spirit. Fruitful investigation flourishes only in a proper soil and blossoms profusely only in a congenial atmosphere. One cannot have investigation without investigators; in some directions money may provide the materials, for the lack of which investigation must go halting, but in all directions investigators must be both born and trained. The inspiring intellectual life of our foremost universities certainly offers a most congenial atmosphere for the growth of that investigative spirit; the furtherance of that spirit is an indispensable factor in a worthy national and cultural progress.

It thus becomes not a supplementary duty but the very purpose of the university to provide an environment so thoroughly suited to the growth of investigation that it cannot but become its natural habitat. Research is indispensable to a university. says President Eliot, "because a university which is not a place of research will not long continue to be a good place of teaching; and, secondly, because this incessant, quiet, single-minded search after new truth is the condition of both material and intellectual progress for the nation and for the race."

It will be well to examine somewhat more closely the two aspects of investigation which I have selected for special emphasis —investigation for training and investigation for discovery. The working ideal of American universities is to provide their students with the maximum opportunities and privileges of which their degree of maturity and responsibility enables them to profit; and at the same time we continue the guidance of their progress in ever more indirect but no less efficient manner, until they strike out confidently, and as a rule creditably, in their chosen walks of life. We have not been tempted to imitate the German system which makes the passage from gymnasium to university an abrupt change from set tasks and stringent discipline to complete liberty with little guidance and no control. While it is proper that conventional ceremonies and new privileges should add zest to the assumption of the toga virilis, it is not proper that mistakes should be encouraged, nor that, for lack of a gradual transition, time and energy and strength should go astray. Men and women should have the liberty of making mistakes; there is a very real danger in over-guidance as well as in license. But the golden mean between these, though a narrow path, is broad enough to be readily found.

In the ideal which American universities attempt to realize, there are to be guide-posts enough to give the young explorer a confident feeling that others have trod the path before him, and to prevent useless wanderings into by-paths and *culs-de-sac*, and yet not enough to take away the incentive of independence and adventure, nor to lose the slightest opportunity to foster self-reliance and courage. It is necessary to understand this ideal and the consequent attitude of both guide and guided to appreciate the function in the university of investigation for training. For it seems to me that no other aspect of university studies can so readily be adapted to this ideal as the investigative aspect. I mean by this not merely the one topic that forms the basis of a thesis (which in the nature of things must often be quite detailed and not comprehensively significant);

but also the research attitude of the seminary, the participation in the problems of fellow-workers in the laboratory and study, the preparation for lectures and demonstrations, the presentation of technical material before clubs and societies, the critical digest of current contributions to learning and the tentative but stimulating first steps in productive authorship. In all these activities the attitude of the student is participative and expressive; not only absorbent but responsive; he must do and dare, he must count and weigh, he must thrust and parry; he is no longer wholly a spectator nor an auditor, he has a part, though a minor one, on the stage; and even the acquaintance with *the scene-painting* and *stage-carpentering* is a useful one for the training of the actor. It is in the special adaptation of investigation to accomplish these ends, to round out the motor side of education, that I see its pedagogical value. Research under judicious guidance is a training in coördination, a training in self-reliance, a training in readiness and resource, a training in reserve and critical ability, a training in construction and expression. It gives zest and dignity to what might otherwise seem to be insipid drudgery; by presenting conditions which must be met as best one can, investigation becomes a stern discourager of hesitancy; by its constant reference to and dependence upon the errors and outgrown opinions of the past, it is a wise encourager of caution and foresight. It teaches both how to look and how to leap. It maketh the full, and the ready, and the exact man. It would be unwise to forget that other aspects of university studies and university life contribute an essential quantum to the furtherance of the same qualities; but considering it with reference to its fitness in a systematic course of higher education, to elicit the full whole-souled response of ambitious youth, and in requiring just that proper measure of guidance and independence suitable to the capacities and purposes of university students, the position of investigation for mental training and discipline cannot hold a subordinate place.

Regarding investigation for discovery, I desire only to touch upon one or two aspects of it which are not so commonly associated with the term as they should be. While there is something to be said—in many departments much to be said—for investigation as a prudent and practical investment, there is no danger in a commercial democracy that this will remain unsaid. It is only in its relations to its constituency that it becomes important for the university to emphasize this aspect of investigations. Still less legitimate is it for a worthy university to exploit the contributions to knowledge which it has been fortunate to have developed within itself as an advertisement of its merits, not in this respect mainly but in general. There is no feature in the management of American universities that in my mind so easily arouses disgust and despair as this much varied but always objectionable heralding of their opportunities and successes. This field may properly be left to the manufacturers of proprietary and dietary specialties.

Investigation for discovery is a university function because of its incentive to the highest activity of those who in their several departments approach the confines of acquired knowledge and attempt to extend or to modify them; because of its contribution to the totality of the university spirit which permeates and stimulates every output of its energies; and, independently of these, because the advancement of learning by the creative capacities of the men of greatest endowment is in itself as proper a function of a university as teaching or the maintenance of libraries and museums.

Regarding its relation to the individual development of the professor, it would be foolish to ignore the fact that teaching and research do not always make an harmonious pair. There will always be in letters and in science a group of men, often marked by genius as her own, who are keenly sensitive to the restraints and routine of instruction. Lowell said that being a professor was not good for him; it damped the gunpowder of his mind, so that "when it took fire at all (which wasn't often), [it] drawled off in an unwilling fuse instead of leaping to meet the first spark." The joy of feeling that the marks of the ball and chain had worn off induced him to write, "If I were a profane man, I should say, 'Darn the College!'" Some mutterings of similar import may occasionally be overheard in the vicinity of laboratories and lecture rooms. The best teacher is not always an investigator, nor the best investigator a teacher. The university should be broad enough to provide for men of both types and set each to work at that which he does best. And yet, because of its influence upon the totality of the university spirit, I believe that in the long run the fruits of instruction will be choicest when they have been ripened in the sunshine of investigation.

To what extent universities will be willing to encourage investigation as a complementary obligation to their other functions is largely a practical question; it depends upon means of support, it depends upon a public spirit liberal enough to appreciate and provide for its development in a spirit of the husbandman who plants the tree the fruits of which he shall not live to enjoy. 'Serit arbores quae seclo prosint alteri.' There are welcome signs that such a spirit is not foreign to our civilization, and that this is one of the respects in which the twentieth century may be expected to exceed the achievements of the nineteenth.

So far as I have attempted to crystallize my contribution to this symposium it may be said to center about these points: Investigation constitutes a motor or expressive factor in education at a stage in which that factor becomes particularly significant. It occupies an important place in the university by reason of its disciplinary value in the direction of self-reliant activity. The place of investigation in building up the spirit that makes for the safest and sanest progress is no less conspicuous. Investigation for discovery is a function coordinate in worth with other purposes of a university, and is more likely than almost anything else to keep the mind of the professor from 'drawling off in an unwilling fuse,' and to make it ready to leap to meet the first spark.

JOSEPH JASTROW.

UNIVERSITY OF WISCONSIN.

IT may be conceded in the beginning of this discussion that a modern university is an institution which devotes attention to all subjects information upon which can be systematized or reduced to a science, and that it is constantly striving to extend the boundaries of knowledge in every branch of human inquiry.

In its strictly educational function it develops a proper conception of these subjects in the minds of its students by the logical and inspired presentation of certain basal facts and underlying principles, with which the learner may build up the mental edifice representing the structural aspect of each subject in its completeness or incompleteness.

With a fairly general agreement upon these points it might be said that the subject for discussion is one which vitally concerns the integrity of the university, and any question of the abstract relation of the university to investigation would imply a most serious state of affairs. I take it for granted, however, that the real theme for consideration is not the ethical relation of the university to research, since its obligations in the matter are invariable and undeniable, but rather one of the practicability and pedagogical expediency of carrying out this obligation.

Can the facilities of a university be used to advantage in the furtherance of research, and what influence does effort of this character exert upon its pedagogical functions?

The most prominent feature in the majority of our universities under their present organization is undoubtedly their academic department, in which the older, often miscalled the elementary, parts of the subjects are presented in a manner which absorbs the greater proportion of the facilities of the institution. The intent of such instruction is most commendable in its thoroughness and honesty of purpose, but here the good and honest intention, as with many others blindly followed, leads to a most iniquitous ending. No university of standing fills its chairs with men who are not prominent by the results of their investigations and active in their present prosecution. Having proceeded so far wisely and well, the administration then falters in its high purpose, and permits, rather insists that practically all of the energy of its members should be expended in the more or less mechanical duties attendant upon elementary instruction, especially in natural sciences, and fails entirely to provide either opportunity or facilities for the development of research work and its use in the presentation of the subjects. Such failure may be due to financial disability, though administrative lapses of judgment are not unknown or infrequent. In either case it is unfair and unfortunate to such a degree as to stretch the conception of honesty to its utmost limits, and to make the name of the university a travesty. Such non-appreciation of the actual importance of investigation is most conducive to stagnation, or indeed it may be taken as a symptom of it, and its deadening, thwarting effect is doing more to retard the development of the American university than any other one cause.

The presentation of any subject by an instructor who is not participating in its development will lack freshness of treatment, sharp distinctions between established and speculative deductions, will be more or less dogmatic, and will fall far short of its possible value, both for culture work and professional training. To this sweeping statement I am bound to add that there are a few teachers, not investigators, whose apparent success in instruction is due to an enduring and contagious enthusiasm which implants a permanent interest in a subject, in the mind of a student, which may lead him to follow it later and elsewhere to a more orderly and natural attack, from which he will gain a proper perspective for the first time. The arousing of enthusiasm and the imparting of information do not constitute the highest form of instruction however, and the teacher who does no more, fails not only in his special office, but also in his duty to bear a share in carrying out the obligations of the institution to society.

So far as investigation as a method of teaching is concerned, it is to be said that the acquisition and systematization of information gained in this manner, have a value both for culture and professional training lacking in any other method. It is a procedure by which the student is led to grasp the chief concepts included in a subject, the principles to be deduced from their orderly arrangement, to trace the manner in which every increment of new fact or advanced thought has been accumulated, and to follow the technique of this development in making his own acquaintance with the subject in its known aspects. So far he has been an investigator merely as a matter of discipline. Later he may project his activities beyond the boundaries of the subject, and by contributions of his own winning, alter its limits and make a readjustment of its generalizations possible and necessary. The value of this investigating, or find out for himself, method of learning is too well established to need more than mention at this time; a value clearly conceded by its almost universal usage. Whether or not a student should be led into the specialization necessary to make discoveries, in his undergraduate days, is a question which may be answered only in the light of information as to his training, his purposes, and his mental capacity. The same may be said of the graduate student, except that the value of investigation for discovery is more immediate in his case if his graduate work logically follows his earlier training.

With the realization of the value of research in the university, it may be said that no worker who is thoroughly in earnest will fail to find means of attack upon some of the problems pressing in upon him, and to use this method in the presentation of his subject, no matter under what straitened circumstances he may find himself. The investigator who does not show this adaptability will certainly encounter ample opportunities for unhappiness.

With a devotion to research in its faculties it needs but the expressed appreciation of the administration to promote the pedagogical practice of investigation to a creditable degree, even if the material facilities are lacking. The extension of investigation to a point where it may actually contribute to the development of a branch of knowledge will depend very largely upon the actual financial resources of the institution, although the born investigator is not easily turned from his path. In any case the needs of a university for research facilities are quite as elemental and quite as pressing as for libraries, chapels, memorial halls, gymnasiums, or any other part of the institution's mechanism, and should receive corresponding attention from those in charge of its organization and administration.

The following statements may be made in conclusion:

1. One of the primal duties of the university is the furtherance of research.

2. The presentation of subjects by instructors not engaged in research will lack originality of treatment and will not be properly inductive.

3. Investigation is itself a method of advanced teaching by which a student comes to a full realization of the structural aspect and relations of a subject, participates in its development, strengthens his mental grasp and broadens his powers of generalization; a method by which the highest form of culture and training is secured.

4. Investigation is, therefore, not only an obligation of the university to society and to its students, but also one of its most effective weapons.

5. Any tendency to the restriction or curtailment of the opportunities for research is to be regarded as a most alarming retrograde movement, which may in time vastly impair the usefulness of the institution compelled to take this step, and is certainly indicative of disabled function or evasion of one of the plainest duties of the university.

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N. Y. Botanical Gardens.

It is hardly necessary to emphasize here the importance of investigation as a part of the training of the university student.

Training in research methods is chiefly valuable in that it stimulates the perception and the imagination and increases the power of self-guidance and immediate productivity. As a means of instruction it is slow and cumbersome and often fails to accomplish its object.

With the rapid growth, in recent years,

of the spirit of research, instruction in the methods of research is regarded as an essential part of the teachers' university training. The same kind of instruction is being rapidly transplanted into the college curriculum, where it may form part of the work of advanced students during their junior and senior years.

We shall not try to point out here the value of research to the university, or to discuss what may be done to give it new scope and direction. Let us rather inquire whether there is not a tendency to confound the university attitude toward investigation as a method of training, with that of the learned society or academy toward research as an end, and whether, as a result of this confusion, our higher educational institutions are not substituting too extensively a training in investigation for more direct methods of instruction.

The criticism may be fairly made that in research work an enormous amount of time is devoted to mechanical details that do not yield adequate returns, either in instruction or in training; that much of this work is begun before the student is properly prepared to undertake it, and done at the expense of the best opportunity he is likely to have of acquiring a broad, sympathetic culture, and a secure foundation knowledge of the subject in which he proposes to specialize; and finally, that the research work to which the student devotes so much of his time rarely, if ever, serves as a preparation for the kind of work by which he expects to earn a living,—namely, teaching in the college or secondary schools.

It seems to me that such criticisms are largely justified, and that they are specially applicable to the biological student, whom I shall have in mind in the discussion that follows.

This is mainly due to the nature of biological work, and to the character of the biologist. The latter is generally an enthusiast who follows his subject for its own sake, without hope of the large financial rewards of the inventive chemist or physicist. In rare cases he may be a man of wealth and leisure, but more generally he has very moderate means and is without the best preliminary training. In the great majority of cases, he must earn his living by teaching, and use his leisure time only for research.

In biology the frontier separating the known from the unknown is everywhere close at hand, and new methods of research make it easy for comparatively untrained workers, with a little guidance, to bring important facts to light.

It is not necessary to devote the long years of training required in music and art, to make the eye and hand of the biologist effective instruments for the performance of his work, and the apprehension of the mere materials with which he deals, taken alone, does not make great demands on his mental resources.

The daily occupation of the biologist may be so absorbing, that once he begins to section and stain, and put things safely away in bottles, he is likely to keep on doing so till he dies.

There is, therefore, a great temptation for the biological student to begin his creative work at an early period, and he is eager to do so because it gratifies his pride to be investigating something, and because, on the whole, investigation is a very entertaining occupation. The instructor is not likely to oppose his inclinations in this direction, since he finds it an easy way of keeping the student busy, and incidentally of clearing up little problems he has no time to work out for himself.

But there is probably no other subject in which there is greater danger of too early specialization than biology, because there is no other science which sends its roots more deeply or intricately into other sciences, or in which the personal equation, the character and training of the man, exerts a greater influence over the interpretation of results.

As the biologist's greatest skill is shown in the marshaling and weighing of a multitude of what must always remain incomplete and fragmentary data, his best preparation for such work will be the formation of that sound judgment which comes from a wide knowledge of his special subjects, and something more than the mere vocabulary of related ones.

The college courses do not usually give the required training, not for lack of time, but because so much time is wasted in getting ready to teach, and in observing the mouthings of science, that there is none left to hear what she has to say.

In some instances the instructor apparently tries to find out how long he can instruct without telling anything, and how long he can keep the student guessing what he is expected to see. After the student has made careful drawings of various organs and covered them with unintelligible names, he is often left to draw his own conclusions as to their meaning and function. This method may satisfy the student's curiosity to get a good interior view of the organization of an earthworm, but it does not enable him to discover what the science of biology has to say on the subject. It is as though one should begin a course in the science of football by requiring the student to make careful drawings of the stitching on the ball, and to section its germ layers, and then leave him to form his own notions as to how the game is played. Such a method is said to be of value in cultivating the powers of observation. But if the teacher of biology would teach biology only, and let the powers of observation alone, better results would be obtained. In my own judgment, you can hardly tell a student too much, or tell it too quickly, provided you tell it so that he can understand.

In the university the student often suffers from a similar lack of direct instruction. He generally finds that two kinds of courses are open to him: in one the treatment of the subject is so elementary that he can afford to ignore it; in the other some subdivision of it is discussed in great detail, and perhaps necessitates the expenditure of so much time and energy in the use of investigation methods that he does not want it, or cannot afford the time to take it.

In these courses, the instructor prides himself on giving the very latest report of the hour, with much controversial matter, better suited for the archives of some learned society than to be detailed in the class or lecture room. A prolonged diet of this kind is depressing, and is apt to leave in the mind of the student a succession of vague impressions of small educational value, and a feeling that it is more important that a certain investigator should receive full credit for having made a discovery than it is to give that discovery its due weight and position.

It has been said that biological instruction in America is not what it pretends to be, because the botanical side of the subject is neglected and most of the time given to zoology. But even the zoological instruction, that is supposed to be biological, is itself one-sided, since it may be treated from the purely morphological standpoint, ignoring altogether the experimental, physiological and ecological sides of the subject.

With all this special work goes a great deal of technique, something that readily degenerates into an interminable puttering over different methods, with very little attention given to the real questions to be solved by them.

On reaching the university the student's first thought is to obtain some problem for his doctor's thesis, and, if he is fortunate, in the selection or assignment of a workable subject, and can obtain material to work with, his best energies are henceforth centered round that particular work, for he is led to believe that his future career depends largely on his discovering at once something of importance.

He feels that his time has been thrown away if at the end of a certain period he has no results on hand worth publishing. In the absence of such results and in his haste to get his degree, there is danger that after prolonged meditation he may unconsciously supply the deficiency by giving to his discoveries an importance they do not possess. By padding his paper with personal and irrelevant details, or by picking an unnecessary quarrel with his predecessors, and with the aid of an elaborate historical summary, he can generally get together an article of sufficient dimensions to produce a favorable impression on the biological community, excepting, of course, the half dozen or so individuals that read it.

In his research work the student is sustained by the thought that he is carrying on some profound investigation. But his work is largely mechanical. It may require a great deal of patience, a little manual skill, and perhaps some intelligence, but it very rarely shows any genuine originality. The student is really seeing and doing what he is told for he has not sufficient knowledge of his subject to steer his own course, or to clearly grasp the significance of the question at issue. Much of the research work of the faithful student type is of this nature. In fact, the instructor does the research, and the student the manual labor.

Another evil likely to arise from the over-emphasis of research work is the danger of a great waste of time and energy on sterile problems. If it is downright cruelty, as Huxley says, to add one unnecessary hour to the work of the medical student, it is no less an offense to assign a line of special inquiry to a candidate for the doctor's degree with a possibility that at the end of one or two years his chances of getting the degree are as far off as ever, because through no fault of his own the work gave negative results, or because his results have been anticipated elsewhere. Another student, more fortunate in the assignment of his problem, may get his degree with the expenditure of half the time and labor.

Of course it may be urged that in most cases no one can know whether a given problem will be fruitful or not till it has been tried, and the candidate must take his chances. He must, no doubt, take his chances in after life, and he accepts the conditions more or less cheerfully, provided he is not asked to wager more time and strength on the hazard than are honestly his.

Meantime the candidate for a doctor's degree has been so absorbed in his research work, that he has not had time to think about his own development or his examinations. It is usually assumed that, when the time comes, 'a few weeks hard plugging will fix that all right,' and experience generally justifies the assumption. In a case that came directly under my own observation, a Japanese student of zoology was to demonstrate his knowledge of botany by describing how they cultivated tea in Japan.

After two or three years of investigation, the graduate student is liberated with an exaggerated idea of his own importance as a contributor to the world's store of knowledge, and quite untrained in the only work he is likely to do well, or even have a chance to try, namely, teaching in the secondary schools.

The layman, looking for a teacher with an up to date equipment for his work, may be impressed by the doctor's voluminous treatise, but he will probably discover, when it is too late, that his candidate has but one imposing garment to conceal his unfitness for the work required, or, worse still, may find that he does not want to teach at all, but to investigate.

It may take several years for such a misfit teacher to adjust himself to his proper environment, and to discover that it is worth more to be a good neighbor and a useful man in the community than it is to be known in Germany.

In conclusion, therefore, it seems to me that by the over-emphasis of research the university is in danger of sacrificing the sound, symmetrical education of the individual for the sake of a too rapid growth of science. The university student should be trained in the methods of investigation, because it may give him fertility and power, not because it is his business or duty to contribute something new to the world's store of knowledge.

As the value of his contribution may or may not afford a measure of his originality or of his ability to teach, the university should not insist too rigidly on an original contribution as a requirement for the doctor's degree, and should eliminate every possible element of chance that may deprive the candidate of his well-earned license to teach, or that may unnecessarily prolong his term of apprenticeship.

The examination for the doctor's degree should precede rather than follow the approval of a thesis, in order to check too early specialization and an undue haste in the publication of fragmentary research work.

The biological material already available for teaching should be condensed and put into logical order for purposes of more direct instruction, and the educational requirements of the medical man, the teacher, and the professional investigator should, so far as necessary, be met separately.

The physiological and experimental sides of biology should receive greater attention, and that kind of out-door work on living animals in their natural surroundings, for which the marine and lake laboratories offer such excellent opportunities, should be specially developed, because among other reasons, of its bearing on the nature work in the public schools. The work done in these laboratories should be formally recognized as part of the requirements for the higher degrees, and the laboratories themselves grafted on to the university and college so as to form as much a part of their equipment as do the library and museum. Results of the greatest importance for biology, in all its relations to education, will surely follow coöperation in this direction.

WM. PATTEN.
DARTMOUTH COLLEGE.

AMERICAN MATHEMATICAL SOCIETY.

THE sixth annual meeting of the American Mathematical Society was held at Columbia University on Thursday, December 28, 1899. On the same and the following day the Chicago Section met at the University of Chicago. Occurring in the holidays, these two meetings are more easily attended than those of other seasons, and afford better opportunities for personal conference and discussion. The annual meeting offers the additional interest of the election of officers, the presentation of annual reports which regularly bear testimony to the remarkable prosperity of the Society, and the general marking of the close of one year of progress and the opening of another. An especially attractive feature of this year's annual meeting was the scholarly Presidential Address of President R. S. Woodward on 'The Century's Progress in Applied Mathematics.' This address, which appears in the present number of SCIENCE, as well as in the next number of the *Bulletin* of the Society, was delivered before an appreciative audience of nearly eighty persons, the members of the American Physical Society attending, by invitation, in a body. During the reading of the address and of Professor Pupin's paper, the chair was occupied by President H. A. Rowland, of the Physical Society. As predicted in the report of the October meeting, the relations of these two societies are becoming more and more intimate and cordial, a tendency which cannot be too highly commended. The results are mutually beneficial. The attendance of members of the Mathematical Society increased more than seventy per cent. over last year, this Society furnishing nearly one-half of the total attendance at the meeting of both bodies.

At the annual election the following officers and members of the Council were chosen: President, R. S. Woodward; First Vice-President, E. H. Moore; Second Vice-President, T. S. Fiske; Secretary, F. N. Cole; Treasurer, W. S. Dennett; Librarian, Pomeroy Laden; Committee of Publication, F. N. Cole, Alexander Ziwet, F. Morley; Members of the Council to serve for three years, Simon Newcomb, Oscar Bolza, L. A. Wait. Suitable resolutions were adopted on the retirement of Professor Jacoby from the office of Treasurer after a service dating from the founding of the Society.

The Council announced the election of the following persons to membership in the Society: Professor William Beebe, Yale University; Dr. J. V. Collins, State Normal School, Stevens Point, Wis.; Professor A. R. Forsyth, Trinity College, Cambridge, England; Professor M. W. Haskell, University of California; Mr. C. A. Noble, University of California; Miss E. N. Martin, Ph.D., Ardmore, Pa.; Mr. E. B. Wilson, Yale University; Miss R. G. Wood, New Haven, Conn. Four applications for membership were reported. The total membership of the Society is now 342, a gain of 27 during the year. About 110 papers were presented before the Society during the year as against 83 in 1898.

The first number of the *Transactions* is now in press and will appear in January. Later numbers will appear at intervals of three months.

The following papers were presented at the Annual Meeting:

(1) DR. G. A. MILLER: 'On the groups which have the same groups of isomorphisms.'

(2) PROFESSOR MAXIME BÔCHER: 'On regular singular points of linear differential equations of the second order whose coefficients are not necessarily analytic.'

(3) DR. VIRGIL SNYDER: 'On cyclical quartic surfaces in space of n dimensions.'

(4) DR. VIRGIL SNYDER: 'On the geometry of the circle.'

(5) MR. W. B. FITE: 'A proof that the commutator subgroup of a group may contain operators which are not commutators.'

(6) J. E. CAMPBELL, M.A.: 'On the types of linear partial differential equations of the second order (in three independent variables) which are unaltered by the transformations of a continuous group.'

(7) PROFESSOR L. E. DICKSON: 'Proof of the existence of the Galois field of order p^r for every integer r and prime number p.'

(8) DR. E. M. BLAKE: 'On plane movements whose point loci are of order not greater than four.'

(9) PROFESSOR R. S. WOODWARD: Presidential Address: 'The century's progress in applied mathematics.'

(10) PROFESSOR M. I. PUPIN: 'The propagation of electrical waves over non-uniform conductors.'

(11) PROFESSOR HENRY TABER: 'The singular transformation of a group generated by infinitesimal transformations.'

(12) DR. J. I. HUTCHINSON: 'On certain relations among the theta constants.'

(13) PROFESSOR E. O. LOVETT: 'Singular solutions of Monge equations.'

F. N. COLE,
Secretary.

COLUMBIA UNIVERSITY.

SCIENTIFIC BOOKS.

Everyday Butterflies. A Group of Biographies. By SAMUEL HUBBARD SCUDDER. Boston and New York, Houghton, Mifflin & Company. 1899. 12mo. Pp. viii + 386. 9 plates, 23 figures; 48 figures in text. Price, $2.00.

This tasteful little volume contains an account of the life-history, habits, and distribution of sixty-two species of the commoner butterflies, which are found in the Eastern States and the Canadian provinces of Quebec and Ontario. It is illustrated by nine plates, eight of which are done in colors, the other being a carefully executed and faithful representation in black and white of an enlargement of the interesting chrysalis of *Feniseca tarquinius*, the curious aphidivorous habits of the larva of which are fully explained by the author. The illustrations in the text are numerous and excellent, and, with the plates, will enable the reader to easily identify the species when encountered in nature.

The study of butterflies is every year gathering new devotees, especially from the rapidly-growing leisure class, and the ranks of the young in our schools and colleges. No field of observation is more accessible and interesting, and none more likely to yield valuable results, from the standpoint of the biologist, than that of entomology. Books, like the one before us, which combine scientific accuracy with a grateful flavor of the woods and the fields, can not fail to stimulate those who are their happy possessors to make researches, which will give charm and delight to life, and may prove of positive scientific interest.

Everything which falls from the pen of Dr. Scudder possesses the merit of literary grace, and, with but very few exceptions, absolute scientific accuracy. If any adverse criticism in general could be passed upon the writings of our learned friend, it is that in his zeal for precision of description and thoroughness of treatment he at times becomes a little prolix. This, however, is a trait wholly absent from the pages of the present book, which are sprightly and popular in style, while profoundly instructive.

Issue must be taken with two statements made by the author on page 281. In speaking of the chrysalis of *Feniseca tarquinius* he says: "Curiously enough, a similar ape's face is seen in the chrysalis of an African butterfly of another genus not very closely related to *Feniseca*, and in an Indian species of the same Oriental genus. Now, in these two cases there is a strong probability that their larval food is plant lice." The reference is to the chrysalis of *Spalgis s-signata*, Holland = *S. lemolea*, H. H. Druce, which I had the pleasure of describing and figuring in *Psyche* Vol. VI., p. 201, Plate IV., and to the chrysalis of *Spalgis epius*, Westwood, described and figured by Aitken in the eighth volume of the *Journal* of the Bombay Natural History Society, Plate A. A careful examination of the structural peculiarities and of the preliminary stages of the genus *Spalgis* shows that it is very closely related to our North American genus *Feniseca*, and any general classification of the lepidoptera belonging to the family Lycænidæ which did not place these genera in propinquity would be in error. The statement of the author that in the case of the two species of *Spalgis* mentioned "there is a strong probability that their larval food is plant lice," overlooks the fact that in both cases the aphidivorous habits of the larvæ have been positively ascertained.

Points like these relating to the habits of exotic species, which are only alluded to in passing, do not in the slightest degree affect the value of the book for the circle of readers for which it is particularly intended, and it may be recommended as altogether one of the most pleasing and instructive contributions made in recent months to a branch of science which is daily growing in importance and popularity.

W. J. HOLLAND.

CARNEGIE MUSEUM, PITTSBURG.

Practical Exercises in Elementary Meteorology. Ginn & Co., Boston. 1899. Pp. xiii + 199.

One does not expect a laboratory manual to be interesting, yet Mr. Ward's volume will prove attractive reading to any one interested in the teaching of meteorology. It contains materials for laboratory work for all school ages and includes the exercises that within a few years constituted the laboratory work in Mr. Ward's course at Harvard.

The author does himself injustice when he states the object of his book is "to lead the pupil to the independent discovery of the most important facts in our ordinary weather conditions." The very judicious comments that accompany the exercises tend rather to the rational end of illustrating the laws of meteorology and the method of meteorological study. The well-considered suggestions to teachers propose that in primary schools the attention of pupils be called on occasion to the more obvious relations of the various weather elements to one another and to us. This as a preparation for the exercises of this volume.

Parts I. and II. suggest observations, instrumental and uninstrumental, to be made by one and another member of the class from day to day and kept in a permanent record throughout grammar and high school years. Mr. Ward has prepared numerous questions designed to bring out the simpler relations of the various elements.

Part III.—Exercises in the construction of weather maps—is presumably to be used in high school years. A table of meteorological data for six consecutive days at all weather bureau stations throughout the country is printed at the end of chapter III. (not chapter VIII., as stands printed always in the text). From this pupils are to construct on blank weather maps the isotherms and isobars for each day and the corresponding temperature and pressure gradients. Other blank maps are to be filled out with wind arrows for each day, and still others with the signs for clear and cloudy sky, etc. Besides these construction exercises others are based on the comparative study of the maps thus drawn.

Part IV. contains Correlations of the Weather Elements and Weather Forecasting. These exercises follow naturally on the preceding, going to published weather maps for their data and tending to illustrate the cyclonic and anticyclonic groups of phenomena and their relationships.

These are very valuable exercises from the nature of the results sought and from the fact that they have that definite character which the young student demands. Generalities are his abhorrence, and while all his studies are in the direction of training to generalize from sufficient data he must be allowed a firm footing on particulars at the outset. The demand that he *formulate a general rule* (p. 117) is one that would leave many a high school pupil bewildered. Perhaps he could do it if told in other words.

Some of the problems in Part V. will be beyond the range of many pupils for this reason of their general character. Moreover, as they seek valid results on questions of importance, such as the relation of relative humidity to the direction of the wind, some use should be made of more extended collections of data, made more carefully than is practicable for school classes. It is a pity to base inductions on any but the best of data. I presume all who are teaching young people to make observations are agreed that the immediate object is to train their faculties and show them the scientific method rather than to acquire results. Indeed, it seems to me important that pupils should be led to recognize clearly the rude character of their work as compared with good standards. For this reason it is especially desirable to avoid drudging at observational and mechanical work. Only so much observation is desirable as will help the pupil to understand the process. When it comes to induction he should use the best results specialists have been able to produce. For similar reasons in some of the weather map exercises in Part III. use might be made of the government maps rather than of those produced by the pupil himself, as some of these will be too bad to use and most of them less easily read than the printed maps. I find classes of 13 and 14 years require three fifty-minute periods for the first satisfactory production of one day's isotherms. To reproduce six such days and then six more for isobars and yet more for other elements is to impose task-work. Most teachers will be content with fewer such tasks and as soon as the principle is grasped pass on to use the printed maps.

Mr. Ward has not claimed, however, to give us exercises in shape for immediate use, but rather to offer material from which we could select according to our needs. The materials he offers are abundant and available.

The descriptions of instruments are very clear and simple, and the historic notes and the comments on phenomena and relations between man and the weather very interesting.

Among the instruments one is rather surprised to see the nephoscope, nor is maker or price indicated in the list of instruments. It is a pity to put a doubly-folded sheet like that in Chapter III. in a school-book. It will certainly be torn in the first year. By printing on both sides one fold might have been avoided and there is no good reason why all the data might not have been printed in the text as wanted day by day.

The fact that so many problems are worked out in the book makes it easier reading but will require the books to be closely watched in the class-room.

The Weather Bureau Meteorological Tables are inserted at the end of the book with an excellent appendix on the 'Equipment of a Meteorological Laboratory.'

The book should prove valuable to every teacher of meteorology.

M. S. W. JEFFERSON.

ELMWOOD, MASS., December 19, 1899.

Bacteria, especially as they are related to the Economy of Nature, to Industrial Processes and to the Public Health. By GEORGE NEWMAN, M.D., Demonstrator of Bacteriology, King's College, London. The Science Series. New York, G. P. Putnam's Sons; London, John Murray. 1899. Pp. 348.

The fact that bacteria are concerned in a variety of natural processes and do not devote themselves exclusively to the causation of disease is beginning to touch the popular imagination and to create a demand for treatises that shall deal with the subject of bacteriology from a general biological standpoint rather than a strictly medical one. An attempt to meet this need has been made in the present instance. Dr. Newman discusses, under separate chapter-heads: The Biology of Bacteria, Bacteria in Water, Bacteria in the Air, Bacteria and Fermentation, Bacteria in the Soil, and Bacteria in Milk, Milk Products and other Foods. These six chapters cover 239 pages out of 348. A chapter is then given to The Question of Immunity and Antitoxins, which is followed, by what seems a singular inversion, with one on Bacteria and Disease, and the book ends with a chapter on Disinfection. Many topics of great interest are considered in these pages, and the author's selection of material and mode of treatment will command general approval. The book is marred, however, by a lax and involved style and contains so many errors of statement as to call seriously for revision. On page 30, for example, it is stated that "boiling for thirty to sixty minutes will kill all bacilli and all spores," and on page 79, "moist heat at the boiling point maintained for five minutes will kill all bacteria and their spores." These statements are not in accord and neither is correct. On page 16 it is erroneously stated that "*Micrococcus agilis* is the only coccus which has flagella and active motion." In the description of Van Ermengem's method of staining flagella (p. 63) it is probably through a typographical slip that a 25.5 per cent. solution of silver nitrate is recommended, and surely the use of boric acid in place of osmic acid in the fixing bath is an unusual procedure. It is hardly a careful form of statement to refer to the power of the tetanus bacillus to produce disease as its 'regular function' (p. 32). The author's definition of the antitoxin unit (p. 263) is incorrect. It is not necessary to multiply instances, but it is to be hoped that subsequent editions may find some of these blemishes removed, since they unquestionably impair the value of an otherwise interesting and useful book.

Two examples of the author's somewhat enigmatic style may be given: "Yet, whilst this general fact is true, we must emphasize at the outset the possibility and practicability of securing absolutely pure sterile milk. Recently some milking was carried out under strict antiseptic precautions, with the above sterile result" (p. 181). "*Budding* occurs in some kinds of yeast, and would be classified by some authorities under spore formation, but in practice it is so obviously a 'budding' that it may be so classified" (p. 16).

E. O. J.

A Treatise on Crystallography. By W. J. LEWIS, M.A., Professor of Mineralogy in the University of Cambridge. Cambridge Natural Science Manuals, Geological Series. Cambridge: At the University Press. 1899. 4to. Pp. xii + 612.

This new text-book of crystallography presents the modern views as to the classification of crystals based on the principles of symmetry. It is devoted exclusively to the geometrical relations of crystal forms and to methods of determining these relations and of representing them graphically.

In the first nine chapters the general properties of crystals are described, including very full discussions of symmetry relations and of the properties of zones. The discussion is geometrical rather than analytical and follows more or less closely the treatises of Miller and Story-Maskelyne. In Chapters VI. and VII., treating of crystal drawing and methods of projection, no mention is made of the gnomonic projection, which now occupies an important place in crystallographic discussion.

The treatment of the general optical and physical properties of crystals of the different systems contained in Chapter X. is very brief and seems hardly adequate in a work of this character.

Chapters XI. to XVIII. are devoted to descriptions of the thirty-two classes of crystals. The classification of these types is essentially that of Groth. A feature of this part of the work is the presentation of a great many examples of crystals of various substances in each class, each crystal being worked out in detail with all the logarithmic computations necessary for the determination of its elements and the indices of its forms. Directions for drawing the forms are also not infrequently given after their determination, and a great deal of useful information in practical crystallography may be found scattered through these examples. But their number seems rather more than necessary, adds very much to the bulk of the book and so scatters the desired information as to reduce its usefulness.

In the final chapter on Goniometers but scant justice is done to the theodolite goniometer, no reference being made to the admirable graphic methods of discussing measurements made with it developed by Federow and Goldschmidt.

A complete index concludes the volume. The excellent typography and text figures deserve a word of praise.

The book hardly commends itself to beginners in crytallography, being too elaborate in its treatment and too mathematical in its presentation. Its greatest service will be to more advanced students doing practical work in the study of crystals.

C. PALACHE.

SCIENTIFIC JOURNALS AND ARTICLES.

THE contents of the *American Journal of Science* for January are as follows:

'Products of the Explosion of Acetylene,' by W. G. Mixture.

'Glaciation of Central Idaho,' by G. H. Stone.

'Pogonia Ophioglossoides,' by T. Holm.

'Graftonite, a new Mineral from Grafton, New Hampshire, and its Intergrowth with Triphylite,' by S. L. Penfield.

'Explorations of the *Albatross* in the Pacific Ocean,' by A. Agassiz.

'Analyses of Italian Volcanic Rocks, II.'; by H. S. Washington.

'Constitution of the Ammonium Magnesium Arseniate of Analysis,' by M. Austin.

THE *Astrophysical Journal* for December contains the following articles:

'Robert Wilhelm Bunsen,' by Henry Crew.

'The Wave-Length of the Corona Line,' by C. A. Young.

'Density of Close Double Stars,' by Alexander Roberts.

'The Densities of the Variable Stars of the Algol Type,' by Henry Norris Russell.

'Note on the Spectrum of *P. Cygni*,' by A. Bélopolsky.

'Apparatus and Method for the Photographic Measurement of the Brightness of Surfaces,' by J. Hartmann.

'The Great Sun-Spot of September, 1898,' by J. Fényi.

'A Spectroscope of Fixed Deviation,' by Ph. Pellin and André Broca.

'Researches on the Arc-Spectra of the Metals,' by B. Hasselberg.

THE contents of *Appleton's Popular Science Monthly* for January include 'The Advance of Astronomy in the Nineteenth Century,' by Sir Robert Ball, 'The Applications of Explosives,' by Professor C. E. Munroe, 'Scenes on the Planets,' by Mr. Garrett P. Serviss, Professor Ward on 'Naturalism and Agnosticism,' by Mr. Herbert Spencer, and 'Old Rattler and the King Snake,' by President David Starr Jordan. The *Monthly* is somewhat altered in appearance, and the price is $3.00 per annum. We trust that its influence may be correspondingly increased.

St. Nicholas magazine, which is so popular with young people and has on the whole exercised such an excellent influence, will with the new year add a department of natural history, under the editorship of Mr. Edward F. Bigelow, editor of *Popular Science*. Six pages, monthly, will be devoted to this new department. Two of these will be given up to the out-door world; two more to indoor study and research, both in nature and science; one to correspondence from the children; and one to a department of 'Questions and Answers.'

SOCIETIES AND ACADEMIES.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

The annual meeting of the Society was held at the Cosmos Club on December 23, 1899. The usual reports of the Secretaries and Treasurer were read and an Amendment to the Constitution proposed at the last annual meeting was adopted. By this action membership in the General Committee is subject to new conditions as far as the ex-Presidents of the Society are concerned.

The election of officers for the coming year resulted as follows:

President: G. M. Sternberg, Surgeon General U. S. A.; *Vice-Presidents:* H. S. Pritchett, Superintendent Coast and Geodetic Survey; C. D. Walcott, Director Geological Survey; L. F. Ward, Geological Survey; Richard Rathbun, Smithsonian Institution; *Secretaries:* J. E. Watkins, National Museum; E. D. Preston, Coast and Geodetic Survey; *General Committee:* Cyrus Adler, Library of Congress; W. A. DeCaindry, War Department; J. H. Gore, Columbia University; G. W. Littlehales, Navy Department; H. M. Paul, Naval Observatory; F. W. True, National Museum; C. K. Wead, Patent Office; I. Winston, Coast and Geodetic Survey; C. F. Marvin, Weather Bureau.

E. D. Preston,
Secretary.

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

The December meeting of the Science Club of the University of Wisconsin was held on the evening of December 18th, the program of the evening being a paper by Mr. S. M. Babcock, dealing with the fat globules of milk.

Mr. Babcock stated that, although the fat globules of milk were discovered about two hundred years ago, no accurate knowledge of their structure, number or size was gained until quite recently. Two hypotheses have been advanced regarding their structure. One is that they are surrounded by a thin membrane of albuminous matter which prevents their uniting when they come into contact and protects them from the solvent action of ether when this is shaken with milk, unless a little acid or alkali is first added to dissolve the membrane. The other hypothesis holds that the globules are free particles of fat emulsified with the serum. It was shown that all phenomena which have been considered to favor a membrane are such as occur also in artificial emulsions, where no true membrane can exist if the fat globules are as small as those of milk, and it was, therefore, concluded that milk is an emulsion. The method of counting fat globules by means of capillary tubes was described and the circumstances which affect their number and size were discussed with the aid of lantern slides.

Wm. H. Hobbs.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of December 18, 1899, Dr. Amand Ravold addressed the Academy on the necessity and means of filtering and otherwise purifying water, especially with reference to freeing it from bacteria, for municipal purposes. The speaker explained the sand-bed filter system as used in Germany and England, and the American mechanical system, represented by two commercial devices. The Wormser filter plate was also described and its characteristics were considered.

William Trelease,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

OBSERVATIONS WITH THE MERIDIAN CIRCLE.

To the Editor of Science: In reading Professor Keeler's most interesting report upon the results of the Lick Observatory, as printed in Science for November 10, 1899, I find a statement on page 669 which, if not a misprint, eclipses all work of a similar character.

In connection with that portion touching upon the Meridian Circle, Professor Keeler states that during the year ending last September, and upon 106 nights, 6000 observations were made with the Meridian Circle.

Now the question I would submit, and upon which I would request information, does Professor Keeler wish it understood that 6000 star places were observed in that time, or are these numbers of observations made up of the determination of the right ascension, declination, nadir point, collimation, level and azimuth, each individual determination of these quantities to be counted as one observation ?

The above figures give as a nightly average 57 observations, and from my experience four or five observations per hour—I mean a complete determination in both right ascension and declination, when one is not working with an assistant and not in zone work—is about the limit.

When it is taken into consideration that one observer sets his circle, reads four microscopes, observes nine or eleven transits, makes two or more bisections in zenith distance, and records all these, reads his level at least once every hour, observes his collimation twice in an evening's work, an average of 57 observations per night is almost, if not quite, unrivaled.

But, as I said before, perhaps what Professor Keeler wished to convey by the word 'observations' is not what I have construed it, a complete determination of the two coördinates of the star place, but may contain two, three or four quantities, which he calls observations.

GEO. A. HILL.

NAVAL OBSERVATORY, WASHINGTON, D. C.

NOTE ON THE FOREGOING LETTER BY PROFESSOR HILL.

IN the part of my report to which Professor Hill refers in his letter, one observation means one complete determination of both coördinates of a star. A complete observation of the nadir (zenith) point and level is also, in accordance with the usual custom, counted as one observation. Collimation and flexure determinations and *mire* readings have not been included.

A reference to our records for the year covered by my report shows that the average number of stars, completely observed in both coördinates during this period by Professor Tucker, was fifty per night. With an assistant reading the microscopes the average number was sixty-two per night of from four to five working hours. The observations, as shown by their probable errors on complete reduction, are of the highest order of precision.

Doubtless this is quick work, but I believe that it is by no means of unprecedented rapidity. It is moreover obvious that a comparison of the work of different instruments, on the basis of such figures as those given by Professor Hill, may be quite misleading, since the rapidity with which observations can be made depends largely on the character of the work which is being done. With a full list like that of Mr. Tucker's during the past year, the stars culminate more rapidly than they can be observed, so that the list has to be gone over several times. The rate of observation then depends upon the observer's quickness and skill. With a list which contains many gaps, stars have to be waited for, and the rate depends upon the list alone.

JAMES E. KEELER.

DARK LIGHTNING.

TO THE EDITOR OF SCIENCE: My attention was drawn to Mr. Clayden's work by an article in *Nature* in which reference was made to a communication in one of the photographic journals. The note in the *Philosophical Magazine* I had somehow overlooked.

Mr. Clayden in his letter states that he was unable to obtain any results with the calcium light or with sunlight, and suggests that there may exist some difference between light from such a source and a source whose excitement is electrical, and that it is not safe to assume that the time factor is the only one, until the image of some non-electrical source has been reversed. I cannot see much difference between the calcium light and the arc, for in both we are dealing with an incandescent solid. To settle the matter definitely I have repeated the experiment with the revolving disc, using a calcium light, and obtained perfect reversed images of the slit on the first trial. Mr. Clayden's failure to get reversal with sources other than the spark was due, I imagine, to a too long exposure. The duration must be something less than 1/15000 sec. The exact point at which the reversing action begins can be easily determined by the revolving disc, and will be investigated shortly by one of our students.

R. W. Wood.

SCIENCE IN THE DAILY PRESS.

To the Editor of Science: In view of the appearance of several articles in the daily press relating to the case of the rapid calculator, Arthur Griffith, and purporting to be written by us, we beg to say that we have written no such article and have seen neither copy nor proof of any such article. We have given to reporters, when asked to do so, the principal facts reported before the Psychological Association. The published accounts have varying degrees of accuracy, a few of them being substantially correct. We are impelled to make this disavowal, for the reason that in some instances we are represented as making claims in regard to the case which we have never made. Persons interested are referred to the Proceedings of the Psychological Association and to the fuller statement of results presently to appear.

E. H. Lindley,
Wm. L. Bryan.

University of Indiana, Jan. 4, 1900.

'NEWSPAPER SCIENCE.'

To the Editor of Science: Some weeks ago in Science, and more recently in *The Psychological Review*, Professor J. H. Hyslop condemned in rather sweeping terms what he called 'newspaper science.' He was incited to do so by the publication of an erroneous and annoying report about himself. But while his irritation was certainly justified, his utterances were a trifle indiscriminate. And it is due both to the daily press, which he thus censures, and to the readers of your pages that attention be called to this fact.

It is true that certain papers indulge in untruthful and sensational stories about scientific men and scientific discoveries. But there are others that do not. To classify these two kinds of newspapers together betrays a lack of careful observation, or a wrong use of the logical faculty; perhaps both. Such a proceeding is hardly worthy of a man who pretends to a strictly scientific method in his ordinary work.

The fact is that, though they are only too scarce, one can easily find both newspapers and newspaper men who possess as keen a perception of the eternal beauty of truth, and are animated by as lively a sense of responsibility to the public, as the average professional scientist. A wider recognition of this fact is needed, not merely in the interests of justice, but in those of science also.

Now the number of persons who read technical reports and periodicals—astronomical, electrical, engineering, medical, psychological, and so on—is only about one-hundredth, or only a thousandth, as great as those who see only the daily papers. The vast majority of people could not understand this literature, anyhow. It needs interpretation and adaptation to popular comprehension. The daily paper, therefore, forms a highly important medium of communication between the original investigator and the general public; and, for better or for worse, it will always perform that function. If, then, men who are themselves engaged in scientific researches of value to mankind, or are identified with institutions devoted to the deposit of scientific collections, would abstain from aiding papers that are notoriously reckless, and encourage by word and definite favors those which treat scientific matters intelligently, conscientiously and accurately, they would promote the diffusion of knowledge to a far greater degree than is now possible, and check the very abuses of which Professor Hyslop complains. Not merely in their comments, but also in their active policy, professional scientists can do much to reform 'newspaper science' if they will.

Amateur.

New York, January 5, 1900.

BOTANICAL NOTES.

A NEW SOUTHERN FLORA.

Professor Tracy has prepared a little book under the title of 'Flora of the Southern United States' for use with Bergen's 'Elements of Botany' (Ginn & Company), which is intended to be used as an elementary manual for field work in systematic botany in the public schools.

The author recognizes the fact that "the ability to identify and name plants is not the object of botanical study, but it is a great assistance in attaining the knowledge which the true student of botany is seeking—an understanding of the laws of life in the vegetable kingdom." He has made it possible by means of keys and easy descriptions for the beginner to obtain some ideas as to how plants are classified, what botanists think as to the relationship of plant groups, and how to proceed in identifying an unknown plant. As far as it goes the book is a modern presentation of taxonomic botany. It deals with seed-plants only. Even the ferns so commonly included in manuals of this kind are not included, while the pupil gets no hint whatever of anything lower in the scale of plant life. This is a mistake, but a very common one, in botanical manuals, and we must perhaps overlook it for the present. It is pleasant to find a modern sequence of families (Engler and Prantl's) and a strictly modern nomenclature.

A NEW BOTANICAL JOURNAL.

WITH the December number the first volume of *Rhodora*, the new journal devoted to the botany of New England, was completed. The idea of a local botanical journal of high grade was a novelty, and its progress during the year was watched with much interest. Now at the end of its first volume we may look over what it has accomplished and judge as to whether a geographical limit is a wise one to be placed upon the field of a scientific journal. By far the greater number of articles deal with flowering plants, and are systematic rather than morphological, although the latter are by no means wanting. The ferns and mosses receive scanty notice, while the algæ and fungi are the subject of frequent papers and notes. Many of these papers have much more than local interest, and might with propriety have appeared in any botanical journal. Of course, there are some 'local notes,' some papers on 'noteworthy plants,' some on 'rare plants,' and some 'additions' to local floras. There is little if any of that species splitting which is too often the bane of local botany. The editorial announcement of a year ago stated that special attention would be given "to such plants as are newly recognized or imperfectly known within our limits, to the more precise determination of plant ranges, to brief revisions of groups in which specific and varietal limits require further definition, to corrections upon current manuals and local floras. to altitudinal distribution, plant associations and ecological problems." 'Ferns, mosses and thallophytes' were promised a share of attention. It is to the credit of the management that the program outlined at the outset has been so well carried out. *Rhodora* has shown that a geographically limited scientific journal may be successful and useful.

CHARLES E. BESSEY.
THE UNIVERSITY OF NEBRASKA.

THE CONFERRING OF UNIVERSITY DEGREES BY THE SMITHSONIAN INSTITUTION.

THE Chairman of the Senate Committee on the District of Columbia, Mr. McMillan, introduced, on January 2d, a bill entitled "An act to authorize the regents of the Smithsonian Institution to confer certain degrees and for other purposes." It provides:

"That the regents of the Smithsonian be, and they are hereby, authorized to appoint a board of five examiners, who shall, with the approval of the said regents, prepare and publish a schedule of courses of studies preparatory to the degrees of master of arts, master of science, doctor of philosophy and doctor of science. The said examiners shall from time to time hold examinations in the City of Washington for the said degrees; and, on the satisfactory completion by any candidate of the prescribed course of studies for either of the above mentioned degrees, shall recommend such a candidate to the regents of the Smithsonian Institution for such degrees. The said regents are hereby authorized to confer, under suitable regulations, the degrees above mentioned and also the honorary degree of doctor of laws. Provided, That no person shall be accepted as a candidate for the degree of master of arts or of doctor of philosophy who has not completed a course of study at least equivalent to the course of study required of candidates for corresponding degrees in the most advanced universities in the United States; and provided further, That the degree of doctor of laws shall be conferred on no more than five persons in any one calendar year.

"Sec. 2. The members of the board of examiners shall hold office during the pleasure of the regents of the Smithsonian Institution. Each examiner shall devote his entire time to the duties of instruction and examination assigned to him by the said regents, and shall receive a salary of $4,000 per annum, except that the chairman of the board shall receive a salary of $5,000 per annum.

"Sec. 3. The said regents shall also appoint, subject to appropriations by Congress, such minor offices, and shall establish such rules, regulations and forms as may be necessary to carry out the purposes of this act. They shall also establish a schedule of reasonable fees to be paid by candidates for examination for degrees, which fees shall be paid into the treasury of the United States to the credit of the Smithsonian Institution.

"Sec. 4. The said regents are hereby authorized to accept and to administer any bequest or gift of real or personal property which may be made to them to establish lectureships, to endow chairs of instruction, to establish fellowships, scholarships or prizes, to purchase land, to erect buildings, or otherwise to carry out the provisions of this act.

"Sec. 5. The sum of $50,000, or so much thereof as may be necessary, is hereby appropriated out of any monies in the treasury not otherwise appropriated, to be expended as other public monies appropriated for the use of the Smithsonian are expended to carry out the purposes of this act."

THE UNIVERSITY OF NEBRASKA.

At the December meeting of the Regents of the University of Nebraska, no election was made of a chancellor to fill the vacancy caused by the resignation of Dr. George MacLean, in July. The committee on chancellor asked for more time.

Dr. Bessey, acting chancellor, reported upon the condition of the University. Six hundred and twenty-two new students entered the University during the fall term, and at the present time there are registered in all departments 1560 students, this not including the students present in the summer session, nor those registered in the School of Music and School of Agriculture (short course). The total registration for the year will probably reach about 2100. The registrations in scientific work are as follows: Botany, 153; Chemistry, 526; Entomology, 25; Geology, 100; Physics, 348; Zoology, 160; in technical lines, Civil Engineering, 54; Electrical Engineering, 70; Mechanical Engineering, 251; in languages, German, 629; Greek, 172; Latin, 407; French, 328; English, 1556; History, 570; Political Science, 215; Law, 151.

Among the material improvements during the year are the steam tunnels for carrying steam heat to the different halls on the campus, the completion of the interior work on Mechanic Arts Hall, and the erection of 'Experiment Station Hall,' and an additional power plant—the two buildings last named being on the University Farm.

In accordance with a report made by a committee of the faculty, the regents designated exactly the constitution of the faculties of the two four-year colleges ('Letters' and 'Science').

On Acting Chancellor Bessey's recommendation, plans were ordered drawn with reference to the eventual removal of the University from its present site in the city to its domain in the suburbs known as the 'University Farm.' Early removal is not contemplated, but all buildings and other improvements on this domain are to be made hereafter with reference to the future removal of the University to its new site.

The acting chancellor called attention to the desirability of continuing the University work throughout the year, as is done in the University of Chicago, and the regents appointed a committee to investigate the matter and to report at a future meeting.

Dr. William W. Hastings was given a short leave of absence to enable him to make anthropometric investigations in northern Mexico. Professor Nicholson, for many years head professor of Chemistry, was given, on his request, a leave of absence for one year, beginning January 1, 1900. During his absence Dr. John White is head professor of the department.

RECENT ADDITIONS TO THE AMERICAN MUSEUM.

THE second portion of the Cope collection containing the Fishes, Amphibia and Reptilia has recently been acquired by the American Museum of Natural History as the munificent gift of President Jesup. It includes 350 described species, represented in the majority of cases by the type specimens. The Amphibian collection is from the Permian formation of Texas, and represents many years' work by Cummings and other collectors. There are also large numbers of primitive reptiles belonging to the Proganausauria and other groups. The Trias is fairly well represented, mainly from Pennsylvania. The Jura is represented by collections both from the Colorado Sandstones and from the Como Beds. The former are the most valuable and in the most complete condition, including, especially, the type of *Camarasaurus* and types of other genera which Professor Cope described but never worked up. The Kansas Cretaceous is represented by a very large collection of Mosasaurs and Pterosaurs in fairly good condition and including many of Cope's types. From the Laramie is an especially fine Hadrosaur, a complete skeleton of Diclonius capable of being mounted, also remains of the Ceratopsia. From other parts of the Mesozoic and from the Tertiary are a great variety of reptile remains more or less complete, including some fine Belodontia, Crocodilia and Chelonia. This supplements the very large reptilian collection already made by the American Museum which will now be worked up for the first time.

At the same time there has been presented to the Museum, by Messrs. Havemeyer, Iselin, Dodge, James and Osborn, the valuable Pampean collection purchased by Professor Cope at the Paris Exposition of 1878. This was the first large exhibition in Europe from the Argentine Republic; it includes several entire skeletons, especially those of the great sabre-tooth tiger, *Machærodus*, and of *Lestodon*, and parts of the skeleton of *Toxodon*, also the carapace of several of the armored Edentates. This collection was mounted for exhibition in Paris and very carefully packed at the time of its purchase by Professor Cope; it has never been unboxed since.

Dr. O. P. Hay, formerly of the Field Columbian Museum, who for some time past has been working in the National Museum, has accepted a position in the American Museum as Assistant Curator of Vertebrate Paleontology and will be especially engaged in the arrangement of the Cope Mesozoic collection; he will enter upon his duties January 15th.

SCIENTIFIC NOTES AND NEWS.

MR. G. K. GILBERT, of the U. S. Geological Survey, has been elected president of the American Association for the Advancement of Science, to fill the vacancy caused by the death of Professor Edward Orton.

WITH the close of the year, Assistant Charles A. Schott, who for nearly fifty years has been the distinguished and energetic chief of the Computing Division of the Coast and Geodetic Survey, retired from that important position in order to devote his whole time to special scientific work. Under Mr. Schott's careful supervision and training has developed a corps of skilled computers equalled by no other scientific bureau. To his labors, perhaps, more than to any other one man's, is due the high scientific character of the results which the Survey has given to the world. The completion last year of the great arc, begun over a quarter of a century ago, marks an epoch in the history of the Division, and, the beginning of the triangulation on the 98th meridian, would seem to be a fitting occasion for relieving Mr. Schott of the burden which he has borne for so many years. His official career has been coincident with the development of the Survey, and his untiring zeal and fidelity have done much to bring about its present standard. Assistant Schott will now devote himself to the discussion of the eastern oblique arc (Maine to Louisiana) and a similar arc in California. His successor is Assistant John F. Hayford, who for several months past has occupied the position of Inspector of Geodetic work, and has thus had general supervision, under the Superintendent's direction, of the field geodetic operations. His assumption of the duties of chief of the Computing Division in addition to his previous duties gives him the supervision of the geodetic operations from the inception of the plans and the beginning of the field work to the publication of the results, an arrangement which, doubtless, will be conducive to efficient coöperation of the field and office and to prompt publication of results. Mr. Hayford has had eight years' experience with the Survey both in field service and office work, and has, therefore, received excellent preparation for his present position.

INVITATIONS have now been sent for the memorial meeting in honor of the late Dr. Daniel Garrison Brinton, to be held in the hall of the Historical Society of Pennsylvania, Philadelphia, on Tuesday evening, January 16th. The American Philosophical Society issues the invitations on the part of

The University of Pennsylvania, The Academy of Natural Sciences, The Numismatic and Antiquarian Society, The Historical Society of Pennsylvania, The Geographical Society of Philadelphia, The Oriental Club of Philadelphia, Jefferson Medical College, The American Association for the Advancement of Science, The Smithsonian Institution, The Bureau of American Ethnology, The United States National Museum, The Anthropological Society of Washington, The American Folk-lore Society, The American Antiquarian Society, The New Jersey Historical Society, The New York Historical Society, The American Oriental Society, The Wyoming Historical and Geological Society, The Chester County Historical Society, The American Museum of Natural History, The Field Columbian Museum, The Peabody Museum of American Archæology and Ethnology, The Peabody Institute of Arts and Sciences, The Loyal Legion.

THE statue of Lavoisier, to be erected in Paris, will probably be unveiled in July of this year. The international subscription amounted to 98,000 francs.

SIR RICHARD THORNE THORNE, K.C.B., F.R.S., principal medical officer to the Local Government Board of England, and distinguished for his labors on behalf of public health, has died at the age of 58 years.

PRESIDENT MCKINLEY has designated the following officials to represent the United States Government at the International Medical Congress, which meets in Paris, in connection with the Exposition, August 2d, next, and to the congress of hygiene and demography, which assembles at the same place, August 10th: For the army Surgeon General Sternberg and Surgeon LaGarde; for the navy, Surgeon General Van Reypen; for the marine hospital service, Surgeon General Wyman and Passed Assistant Surgeon Rosenau.

MR. FRANK LENEY, of the Geological Department of the British Museum, has been appointed assistant curator of the Norwich Museum.

DR. LABOURAND has been appointed director of a laboratory newly established by the Municipal Council of Paris, his chief duties being to make inspections of the city schools with a view to diseases of the skin.

THE position of chemist, New York State Board of Health, will be filled on or about January 27th. The examination will consist entirely of practical questions relating to analysis of food products and questions relating to experience and training of the candidates.

AT a meeting of the American Ethnological Society, held December 19th, at the American Museum of Natural History, the following officers were elected for the ensuing year:

President, Mr. Morris K. Jesup; *First Vice-President*, General Grant Wilson; *Second Vice-President*, Professor Franz Boas; *Recording Secretary*, Livingston Farrand; *Corresponding Secretary*, Marshall H. Saville; *Treasurer*, Mr. Frederick Hyde, Jr.

THE Australasian Association for the Advancement of Science is holding its annual meeting this week at Melbourne, under the presidency of Mr. R. L. J. Ellery.

THE eighth International Geological Congress will be held in Paris from August 16th to 26th. The sessions will be divided into four sections, as follows: (1) General and technical geology; (2) stratigraphy and paleontology; (3) mineralogy and petrography; (4) economic geology and hydrography.

THE New York State Museum has recently acquired from Mr. C. J. Sarle an interesting collection of several hundred specimens representing a new crustacean fauna from dark shales at the base of the Salina beds of western New York. These contain numerous species of the merostoms *Eurypterus Pterygotus* and other genera, which have not before been observed.

THE German Imperial Government will contribute an annual subsidy of $5,000 toward the

Institute of Tropical Hygiene, to be opened at Hamburg on October 1st.

MR. MARSHALL H. SAVILLE left New York on December 22d for Mexico to conduct archæological investigations for the department of anthropology of the American Museum of Natural History.

PROFESSOR FREDERICK STARR, of the University of Chicago, is on an exploring trip in Mexico to continue his anthropological researches.

REUTER'S AGENCY announces that the expedition of Baron Toll, organized for the exploration of the New Siberia Islands and Sannikoff Land, to which no man has yet penetrated, will set out in June next from a Norwegian port, whence it will proceed to the mouth of the Lena, on the banks of which river, at a point above the town of Yakutsk, it will pass the winter. During the summer of 1901 the expedition will begin its explorations towards the north, picking up *en route* a detachment which will be sent forward from the main body during March, with a sufficient supply of dogs.

THE Smithsonian Institution has issued a catalogue of its publications available for distribution in December, 1899. The catalogue can probably be obtained on application, and should be in the hands of men of science, as many valuable papers, reprints and monographs can be secured at a comparatively small price.

THE publishers, MM. Georges Carré and C. Naud, 3 rue Racine, Paris, propose to issue an *Annuaire des Mathématiciens*, containing the names, addresses, etc., of all who are engaged in studying or teaching mathematics. The publishers ask the coöperation of all mathematicians, who are requested to forward their names and addresses.

Nature reports that the Brussels Academy of Sciences has awarded the prize of six hundred francs, for an important contribution to geometry, to M. Léon Autonne, of the University of Lyons. The prize of six hundred francs for anatomical and systematic investigations of insects of the group Apterygota (Thysanura and Collembola) has been awarded to M. Victor Willem, of the University of Ghent. M. F. Keelhoff, of the same University, has been awarded the Prix Charles Lemaire (interest on twenty-five thousand francs) for a work entitled 'Note sur le travail des forces élastiques.' The decennial prize of five thousand francs for botanical science has been awarded to Professor Alfred Cogniaux; and a prize of the same value for chemistry and physics has been given to Professor Louis Henry. To fill vacancies caused by death, the Academy has elected as foreign associates in the section of mathematics and physics, Sir G. G. Stokes, Professor Moissan and Professor Jordan. In the section of natural sciences, M. C. Vanlair has been elected a *membre titulaire*, Professors Pelseneer and Gravis have been elected correspondents, and Sir John Murray and M. Maupas have been elected associates.

THE Berlin correspondent of the London *Times* states that the plan and details are now published of the vessel which is being built at the Howaldt Shipbuilding Yard at Kiel for the German Antarctic expedition. The ship in question will be built of wood, the only material strong and elastic enough to resist the pressure of the ice. In form she will be somewhat rounder than the *Fram*, and will not fall away towards the keel in the same manner. It will be remembered that at the Geographical Congress in Berlin, Dr. Nansen himself expressed the opinion that the shape of the *Fram* would not be suitable for the heavy weather of the southern seas. In order to strengthen the ship against the pressure of the ice, the middle deck will be built very nearly on the level of the water-line. Protection against floating ice will be afforded by a triple coating of oak, pitch-pine and South American greenwood, and the bow and stern will be especially protected by steel bands. The length of the ship will be about 46 meters, the breadth between 10 and 11 meters, and the draught about five meters. She will be constructed to carry coal and other stores sufficient for three years, and will contain accommodation for five scientific observers, five officers and a crew of about 20 men. Each of the scientific travelers and each of the officers will have his own cabin. Four rooms will be assigned to the crew. The engine and the boiler will be placed in the stern, between the living rooms. The center of the ship will be occupied by the rooms for scientific work and the forecastle will contain space for 50 Arctic dogs. The ship will be rigged as a three-masted schooner. Two steam winches will serve the anchor and will also be used for scientific purposes. The ship will be illuminated throughout with electric light. The Howaldt Shipbuilding Yard, which is under a contract to have the ship built by the 1st of May, 1901, and fitted out not later than the end of August, 1901, has already begun the construction. A model of the vessel will be shown at the Paris Exhibition.

LECTURES given or about to be given before the Royal Institution, London, are as follows: Mr. C. Vernon Beys, six Christmas lectures (specially adapted for young people) on Fluids in motion and at rest; Professor E. Ray Lankester, twelve lectures on the Structure and classification of fishes; Dr. W. H. R. Rivers, three lectures on the Senses of primitive man; Professor H. H. Turner, three lectures on Moddern astronomy; Dr. Charles Waldstein, three lectures on Recent excavations at Argive Heræum (in Greece), three lectures by Sir Hubert H. Parry; Mr. W. L. Courtney, three lectures on the Idea of tragedy in ancient and modern drama; the Right Hon. Lord Rayleigh, six lectures on Polarized light. The Friday evening meetings will begin on January 19th, when a discourse will be given by the Right Hon. Lord Rayleigh, on Flight; succeeding discourses will probably be given by the Hon. C. A. Parsons, Professor J. Reynolds Green, Mr. H. Warrington Smyth, Professor J. H. Poynting, Major Ronald Ross, Professor Frank Clowes, Sir Benjamin Stone, M.P., Professor J. Arthur Thomson, Sir A. Noble, Professor Dewar and others.

UNIVERSITY AND EDUCATIONAL NEWS.

MR. JOHN D. ROCKEFELLER has given $100,000 to Columbia University to endow the chair of psychology.

MR. ANDREW CARNEGIE has given $300,000 to Cooper Union, New York City, and $200,000 has been contributed by Abram S. Hewitt and Mr. Edward Cooper. This will enable the Union to establish courses in mechanic arts.

SYRACUSE UNIVERSITY receives $25,000 by the will of the late Erastus F. Holden, of Syracuse.

THE Italian Parliament has voted a sum of 1,300,000 lire for the erection of new buildings for the University of Bologna.

PRESIDENT J. M. CRAFTS, of the Massachusetts Institute of Technology, has presented his resignation, to take effect at the close of the present academic year. In his letter of resignation, he says: "My reasons for taking this step at the time are founded upon my desire to return to purely scientific occupations. My term in office has shown me the wide field of educational problems, both within and outside the Institute, which should be studied, and I have found that such studies and the performance of administrative duties, although not in themselves burdensome, leave little freedom for the pursuit of experimental science. A choice must be made between administrative and scientific occupations, and it is the latter which I wish to choose."

EDWIN GRANT DEXTER, A.M. (Brown), Ph.D. (Columbia), now of the State Normal College, Greeley, Colo., has been elected professor of pedagogy in the University of Illinois.

MR. E. M. BLAKE, Ph.D., who was recently elected to an honorary fellowship in mathematics at Cornell University, has entered upon his work there. Mr. Blake received his doctor's degree from Columbia University in 1893, after which he spent two years there as instructor in Barnard College. He spent the year '95–'96 as a student in Leipzig, Berlin and Göttingen, and in '96–'98 was instructor in mathematics in Purdue University. Since leaving Purdue, Dr. Blake has been a student in Paris; his investigations thus far have been chiefly in kinematics.

BY a recent Ministerial decree, M. Sergejevich, whose unpopularity with the students of the University of St. Petersburg is said to have been one of the chief causes of the disturbances that have occurred among them, has been relieved of his functions as Rector of the University of St. Petersburg. He has been succeeded by Professor Holmstein, who is credited with liberal tendencies.

SCIENCE

FRIDAY, JANUARY 19, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE CENTURY'S PROGRESS IN APPLIED MATHEMATICS.

II.

ANOTHER question of widely general, and of peculiar mathematical interest, is the problem first attacked by Fourier, of the distribution and consequent effects of the earth's internal heat. The most interesting phase of this question is that which relates to the time that has elapsed since the crust of the earth became stable and sufficiently cool to support animal life. It is now nearly forty years since Lord Kelvin* startled geologists especially by telling them that Fourier's theory of heat conduction forbids anything like such long intervals of time as they were in the habit of assigning to the aggregate of paleontological phenomena. On several occasions since then Kelvin has restated his arguments with a cogency that has silenced most geologists if it has not convinced most mathematicians. Quite recently, however, the question has become somewhat less one-sided, since geologists and paleontologists are beginning to defend their positions† while that of

*In a memoir 'On the secular cooling of the earth,' *Trans. Royal Society of Edinburgh*, 1862. Republished in Kelvin and Tait's Treatise on Natural Philosophy, appendix D. Kelvin's latest paper on this subject is entitled 'The age of the earth as an abode fitted for life,' and is published in *Philosophical Magazine*, January, 1899; also in SCIENCE, May 12, 1899.

† See Professor T. C. Chamberlin's paper, "Lord

Kelvin is being attacked from the mathematical side.* My own views on this subject were expressed somewhat at length ten years ago, in the address already referred to, and it seems unnecessary here to go into the matter any further than to reaffirm my conviction that the geologists have adduced the weightier arguments. Beautiful as the Fourier analysis is, and absorbingly interesting as its application to the problem of a cooling sphere † is, it does not seem to me to afford anything like so definite a measure of the age of the earth as the visible processes and effects of stratification to which the geologists appeal. In short, the only definite results which Fourier's analysis appears to me to have contributed to knowledge concerning the cooling of our planet are the two following, namely: first, that the process of cooling goes on so slowly that nothing less than a million years is a suitable time unit for measuring the historical succession of thermal events; and secondly, that this process of cooling goes on substantially as if the earth possessed neither oceans nor atmosphere.

It was the well-founded boast of Laplace in the early part of the century that astronomy is the most perfect of the sciences;* and expert contemporary opinion, as we have seen in the case of no less a personage than Green, agreed that the 'Mécanique Céleste' left little room for further advances. Indeed, it would appear that the completeness and the brilliancy of the developments of celestial dynamics during the half century ending with 1825 (the period of Laplace's activity) completely overshadowed all other sciences and retarded to some extent the progress of astronomy itself. The stupendous work of Laplace was chiefly theoretical, however, and he was content in most cases with observational data which accorded with theory to terms of the first order of approximation only. He was probably not so profoundly impressed as men of science at this end of the century are with the necessity of testing a theory by the most searching observational means available. In fact, in elaborating his methods and in applying his theories to the members of the solar system, it has been essential for his disciples to display a degree of ingenuity and a persistence of industry worthy of the master himself. But the prerequisite to progress in celestial mechanics consisted not so much in following up immediately the lines of investigation laid down by Laplace, as in perfecting the methods and in increasing the data of observational astronomy.

Kelvin's address on the age of the earth as an abode fitted for life,' SCIENCE, June 30, 1899; also Sir Archibald Geikie's presidential address to Geological Section of the British Association for the Advancement of Science, Dover meeting, 1899.

* Notably by Professor John Perry. See *Nature*, January 3, and April 18, 1895.

† I have recast this problem of Fourier in two papers published in the *Annals of Mathematics*, Vol. III., pp. 75–88 and pp. 129–144. The solution there given is the only one, so far as I am aware, which lends itself to computation for all values of the time in the history of cooling. A point of much mathematical interest on which this solution depends is the equivalence of the two following series:

$$ru = \frac{2r_0u_0}{\pi}\sum_{n=1}^{n=\infty}\left(\frac{-1}{n}\right)^{n+1} e^{-a^2(n\pi/r_0)^2t}\sin n\pi\frac{r}{r_0},$$

$$= ru_0 - \frac{2r_0u_0}{\sqrt{\pi}}\sum_{n=0}^{n=\infty}\int_{(2n+1)m_0-m}^{(2n+1)m_0+m} e^{-z^2}dz.$$

In these u is the temperature at a distance r from the center of the sphere at any time t; u_0 is the initial uniform temperature of the sphere; r_0 is the radius of the surface of the sphere; a^2 is the diffusivity, supposed constant; and $m = r/(2\sqrt{t})$, $m_0 = r_0/(2a\sqrt{t})$. It will be observed that when the first series (which is Fourier's) converges very slowly, the second converges very rapidly, and vice versa. It will be seen also, that the series refuse, as they should, to give values of the temperature corresponding to negative values of the time.

* "L'Astronomie, par la dignité de son objet et par la perfection de ses théories, est le plus beau monument de l'esprit humain, le titre le plus noble de son intelligence." Système du Monde, Ed., 1884, p. 486.

The development of this branch of science along with the development of the closely related science of geodesy, is a work essentially of the present century, and must be attributed chiefly to the German school of astronomers led by Gauss and Bessel. It is to these eminent minds, as well known in pure as in applied mathematics, that we are indebted for the theories, and for the most advantageous methods of use, of instrumental appliances, and for the refined processes of numerical calculation which secure the best results from observational data. It is a fortunate circumstance, perhaps, considering the irreverence which some modern pure mathematicians show for numerical computations, that Gauss and Bessel began their careers long before the resistless advent of the theory of functions and the theory of groups.

The story of the opportune discovery of the planet Ceres, as related by Gauss himself in the preface to his Theoria Motus Corporum Cœlestium, is well known; but it is less well known that the merit of this magnificent work lies rather in the model groups of formulas presented for the precise numerical solution of intricate problems than in the facility afforded for locating the more obscure members of the solar system. Indeed, the works of Gauss and Bessel are everywhere characterized by a clear recognition of the important distinction between those solutions of problems which are, and those which are not, adapted to numerical calculation. They showed astronomers how to systematize, to expedite, and to verify arithmetical operations in ways which were alone adequate to the accomplishment of the vast undertakings which have since been completed in mathematical geodesy and in sidereal astronomy.

Among the most important contributions of these authors to geodesy and astronomy in particular, and to the precise observational sciences in general, is that branch of the theory of probability called the 'method of least squares.'* No single adjunct has done so much as this to perfect plans of observation, to systematize schemes of reduction, and to give definiteness to computed results. The effect of the general adoption of this method has been somewhat like the effect of the general adoption by scientific men of the metric system; it has furnished common modes of procedure, common measures of precision, and common terminology, thus increasing to an untold extent the availability of the priceless treasures which have been recorded in the century's annals of astronomy and geodesy.

When we pass from the field of observational astronomy to the more restricted but more intricate field of dynamical astronomy, it is apparent that Laplace and his contemporaries quite underestimated the magnitudes of the mathematical tasks they bequeathed to their successors. Laplace, almost unaided, had performed the unparalleled feat of laying down a complete outline of the 'system of the world'; but the labor of filling in the details of that outline, of bringing every member of the solar system into harmony at once with the simple law of gravitation and with the inexorable facts of observation, is a still greater feat which has taxed the combined efforts of the most acute analysts and the most skillful computers of the preceding and present generation.

It is impossible within the limits of a semi-popular address to do more than mention in the most summary way the extraordinary contributions to dynamical astronomy made especially during the present

* Gauss's fundamental paper in this subject is "Theoria combinationis observationum erroribus minimis obnoxiæ," and dates from 1821. Werke, Band IV.

Bessel's numerous contributions to this subject are found in his "Abhandlungen" cited above.

half century, contributions alike formidable by reason of their bulk and by reason of the complexity of their mathematical details. An account of the theory of the perturbative function, or of the theory of the moon, for example, would alone require space little short of a volume.* To mention only the most conspicuous names, there is the pioneer and essentially prerequisite work of the illustrious Gauss and the incomparable Bessel. There is the remarkable work of the brilliant Leverrier (1811–1877), and the not less brilliant Adams (1819–1892),† well known to popular fame by reason of what may be called their mathematical discovery of the planet Neptune. Then came the monumental 'Tables de la Lune' ‡ from the arithmetical laboratory of the indefatigable Hansen; and this marvellous production was quickly followed (1860) by the equally ponderous, and mathematically more important, 'Théorie du Mouvement de la Lune'§ from the pen of the admirably fertile and industrious Delaunay. And finally, there is the still more elaborate work, bringing this great problem of the solar system well-nigh to completeness of solution, which, by common consent, is credited to the two preceding presidents of the American Mathematical Society. || Probably no mathematico-physical undertakings of the century have yielded so many definite, quantitative results to the permanent stock of knowledge as the researches in dynamical astronomy.

*A good account of the progress in dynamical astronomy from 1842 to 1867 is given by Delaunay in 'Rapport sur les Progrès de l'Astronomie,' Paris, 1867.

† The papers of Adams have been edited by Professor W. G. Adams and supplied with a biographical memoir by Professor J. W. L. Glaisher, under the title 'Scientific Papers of John Couch Adams,' Cambridge, at the University Press, Vol. I., 1896.

‡ Published by the British government in 1857.

§ *Mémoires de l'Académie des Sciences de l'Institut Impérial de France,* Tomes XXVIII., XXIX.

|| For an account of the more recent work of Gyldén and Poincaré, reference is made to the presidential address of Dr. G. W. Hill, "Remarks on the progress of celestial mechanics since the middle of the century"; *Bulletin American Mathematical Society,* 2d series, Vol. II., No. 5, p. 125.

But notwithstanding the astonishing degree of perfection to which this science has been brought, there are still some outstanding discrepancies which indicate that the end of investigation is yet a long way off. The moon, which has given astronomers as well as other people, more trouble than any other member of the solar system, is still devious to the extent of a few seconds in a century. The earth, also, it is suspected, is irregular as a time-keeper by a minute but sensible amount;* while it has been proved recently by the exquisite precision of modern observations, that the earth's axis of rotation wanders in a complex way through small but troublesome angles from its mean position, thus causing variations in the astronomical latitude of a place.†

* The effect of tidal friction on the speed of rotation of the earth appears to have been first explained by Ferrel in a 'Note on the influence of the tides in causing an apparent acceleration of the moon's mean position.' This paper was read before the American Academy of Arts and Sciences, in December, 1864, only a few weeks before Delaunay read a similar paper before the French Academy. See Ferrel's autobiography cited above. See also Delaunay's account of his own work in 'Rapport sur les progrès de l' astronomie,' Paris, 1867.

† The cause of such variations is found in the relative mobility of the parts of the earth, especially in the mobility of the oceans and atmosphere. Three types of variation may occur, namely: 1st, that due to sudden changes in the relative positions of the parts of the earth's mass; 2d, that due to secular changes in position of those parts; and 3d, that due to periodic shiftings of those parts. Of these the most important appears to be the periodic type. A surprising, and as yet not fully explained, discrepancy brought to light by the discovery of latitude variations is the fact that the instantaneous axis of rotation of the earth makes a complete circuit around the axis of figure in about 428 days, instead of in about 305 days as has been supposed from the time of Euler down to the present decade. The discovery of this discrepancy is due to

A question of intense interest to astronomers in the early part of the century is that of the stability of the solar system. Lagrange, Laplace, and Poisson thought they had demonstrated that, whatever may have been the origin of this system, the existing order of events will go on indefinitely. This conclusion seems to have been alike satisfactory to scientific and unscientific men. But with the growth of the doctrine of energy and with the developments of thermodynamics, it has come to appear highly probable that the solar system has not only gone through a long series of changes in the past, but is destined to undergo a similarly long series of vicissitudes in the future. In other words, while our predecessors of a century ago thought the 'system of the world' stable, our contemporaries are forced to consider it unstable.*

But interesting as this question of stability still is, there is no pressing necessity, fortunately, for a determination of the ulterior fate of our planet. A more important question lies close at hand, and merits, it seems to me, immediate and serious investigation. This question is the fundamental one whether the beautifully simple law of Newtonian attraction is exact or only approximate. No one familiar with celestial mechanics or with the evidence for the law of gravitation as marshalled by Laplace in his 'Système du Monde' can fail to appreciate the reasons for the profound conviction, long held by astronomers, that this law is exact. But on the other hand no one acquainted with the obstinate properties of matter can now be satisfied with the Newtonian law until it is proved to hold true to a much higher degree of approximation than has been attained hitherto.* For, in spite of the superb experimental investigations made particularly during the past quarter of a century by Cornu and Baille,† Poynting,‡ Boys,§ Richarz and Krigar-Menzel,|| and Braun,¶ it must be said that the gravitation constant is uncertain by some units in the fourth significant figure, and possibly by one or two units even in the third figure;** thus falling, along with the sun's parallax, the annual stellar aberration, and the moon's mass, amongst the least well determined constants of the solar system. Here then is a fruitful field for research. The direct measurement of the gravitation constant to a much higher degree of precision seems to

Dr. S. C. Chandler and was announced in the *Astronomical Journal*, No. 248, November, 1891. For the mathematical theory of this subject and for titles of the principal publications bearing on this theory, reference may be made to the author's paper on 'Mechanical interpretation of variations of latitudes,' *Astronomical Journal*, No. 345, May, 1895; and to a paper by S. S. Hough on 'The rotation of an elastic spheroid,' *Philosophical Transactions*, No. 187, 1896.

* See a review of this subject by M. H. Poincaré, "Sur la stabilité du système solaire," in *Annuaire du Bureau des Longitudes*, for 1898.

* As to the degree of precision with which the Newtonian law is established by astronomical data, see Professor Newcomb's "Elements of the four inner planets and the fundamental constants of astronomy," Supplement to American Ephemeris and Nautical Almanac for 1897, Washington, 1895.

† *Comptes rendus*, LXXVI., 1873.

‡ The Mean Density of the Earth, by J. H. Poynting, Chas. Griffin & Co., London, 1894.

§ *Philosophical Transactions*, No. 186, 1895.

|| Sitzungsberichte, Berlin Academy, Band 2, 1896.

¶ *Denkschriften*, Math. Natur. Classe, Vienna Academy, Band LXIV., 1897.

** The results of the investigators mentioned for the gravitation constant are, in C. G. S. units, as follows, the first result having been computed from data given by MM. Cornu and Baille in the publication referred to:

Cornu and Baille (1873)	6668×10^{-11}
Poynting (1894)	6698×10^{-11}
Boys (1894)	6657×10^{-11}
Richarz and Krigar-Menzel (1896)	6685×10^{-11}
Braun (1897)	6658×10^{-11}

Regarding these as of equal weight, their mean is 6673×10^{-11} with a probable error of ± 5 units in the fourth place, or 1/1330th part. This is of about the same order of precision as that deduced by Professor Newcomb from astronomical data.

present insuperable obstacles ; but may not the result be reached by indirect means, or may it not be possible to make the solar system break its Sphinx-like reticence of the centuries and disclose the gravitational mechanism itself?

Just as the theories of astronomy and geodesy originated in the needs of the surveyor and navigator, so has the theory of elasticity grown out of the needs of the architect and engineer. From such prosaic questions, in fact, as those relating to the stiffness and the strength of beams, has been developed one of the most comprehensive and most delightfully intricate of the mathematico-physical sciences. Although founded by Galileo, Hooke, and Mariotte in the seventeenth century, and cultivated by the Bernoullis and Euler in the last century, it is, in its generality, a peculiar product of the present century.* It may be said to be the engineer's contribution of the century to the domain of mathematical physics, since many of its most conspicuous devotees, like Navier, Lamé, Rankine, and Saint-Venant, were distinguished members of the profession of engineering; and it is a singular circumstance that the first of the great originators in this field, Navier, should have been the teacher of the greatest of them all, Barré de Saint-Venant. † Other great names are also prominently identified with the growth of this theory and with the recondite problems to which it has given rise. The acute analysts, Poisson, Cauchy, and Boussinesq, of the French school of elasticians ; the profound physicists, Green, Kelvin, Stokes, and Maxwell, of the British school; and the distinguished Neumann (Franz Ernst, 1798–1895), Kirchhoff (1824-1887), and Clebsch (1833–1872), of the German school; have all contributed heavily to the aggregate of concepts, terminology, and mathematical machinery which make this at once the most difficult and the most important of the sciences dealing with matter and motion.

The theory of elasticity has for its object the discovery of the laws which govern the elastic and plastic deformation of bodies or media. In the attainment of this object it is essential to pass from the finite and grossly sensible parts of media to the infinitesimal and faintly sensible parts. Thus the theory is sometimes called molecular mechanics, since its range extends to infinitely small particles of matter if not to the ultimate molecules themselves. It is easy, therefore, considering the complexity of matter as we know it in the more elementary sciences, to understand why the theory of elasticity should present difficulties of a formidable character and require a treatment and a nomenclature peculiarly its own.

While it would be quite inappropriate on such an occasion to go into the mathematical details of this subject, I would recall your attention for a moment to the surprisingly simple and beautiful concepts from which the mathematical investigation proceeds rapidly and unerringly to the equations of equilibrium or motion of a particle of any medium. The most important of these are the concept which relates to the stresses on the particle arising from its connection with adjacent parts of the medium, and

* An admirable history of this science, dealing with its technical aspects, was projected by Professor Isaac Todhunter and completed by Professor Karl Pearson, under the title "A History of the Theory of Elasticity and the Strength of Materials from the time of Galilei to the present time." Cambridge, at the University Press: Vol. I., Galilei to Saint-Venant, 1886; ol. VII., Parts I. and II., Saint-Venant to Lord Kelvin, 1893.

A capital though abridged history of the science is given by Saint-Venant in his annotated edition of Navier's Résistance des Corps Solides, troisième édition, Paris, 1864.

The history of Todhunter and Pearson is dedicated to Saint-Venant, who has been fitly called 'the dean of elasticians.'

† And this illustrious master has left a worthy pupil in M. J. Boussinesq, Professor in the Faculty of Sciences, Paris.

the concept with regard to the distortions of the particle which result from the stresses. If the particle be a rectangular parallelopiped, for example, these stresses may be represented by three pressures or tensions acting perpendicularly to its faces together with three tensions acting along, or tangentially to, those faces. Thus the adjacent parts of the medium alone contribute six independent force components to the equations of equilibrium or motion; and the stresses, or the amounts of force per unit area, which produce these components are technically known as tractions or shears according as they act perpendicularly to or tangentially along the sides of the particle.* Corresponding to these six components there are six different ways in which the particle may undergo distortion. That is, it may be stretched or squeezed in the three directions parallel to its edges; or, its parallel faces may slide in three ways relatively to one another. These six different distortions, which lead in general to a change in the relative positions of the ends of a diagonal of the parallelopiped, are measured by their rates of change, technically called strains, and distinguished as stretches or slides according as they refer to linear or angular distortion.†

It is from such elementary dynamical and kinematical considerations as these that this theory has grown to be not only an indispensable aid to the engineer and physicist, but one of the most attractive fields for the pure mathematician. As Pearson has remarked, "There is scarcely a branch of physical investigation, from the planning of a gigantic bridge to the most delicate fringes of color exhibited by a crystal, wherein it does not play its part."* It is, indeed, fundamental in its relations

* The terminology here used is that of Todhunter and Pearson, History of the Theory of Elasticity and Strength of Materials, Vol. I., Note B.

† The terminology and symbology of the theory of elasticity appear to be more highly developed than those of any other mathematical science. A comparison of the terms and symbols of elasticity with those of the older subject of hydromechanics, as shown, in part, below, is instructive:

IN ELASTICITY.

Stresses.		Strains.	
Tractions	p_{xx}, p_{yy}, p_{zz}	Stretches	s_x, s_y, s_z
Shears	p_{yz}, p_{zx}, p_{xy}	Slides	σ_{yz}, σ_{zx}, σ_{xy}

Shifts, or components of displacement: u, v, w

Shift-fluxions, or space rates of change of shifts: $\frac{\partial u}{\partial x}, \frac{\partial u}{\partial y}, \frac{\partial u}{\partial z}$, $\frac{\partial v}{\partial x}$, etc., $\frac{\partial w}{\partial x}$, etc.,

Dilitation, $\theta = s_x + s_y + s_z = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}$

Twists:
$$\tau_{yz} = \frac{1}{2}\left(\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}\right),\quad \tau_{zx} = \frac{1}{2}\left(\frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}\right),\quad \tau_{xy} = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)$$

Displacement potential in irrotational, or pure, strain.

IN HYDROMECHANICS.

Fluid pressure p

Component velocities: u, v, w

Space rates of change of component velocities: $\frac{\partial u}{\partial x}, \frac{\partial u}{\partial y}, \frac{\partial u}{\partial z}$, $\frac{\partial v}{\partial x}$, etc., $\frac{\partial w}{\partial x}$, etc.,

Expansion, $\theta = \frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z}$

Component spins, or components of molecular rotation:
$$\xi = \frac{1}{2}\left(\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}\right),\quad \eta = \frac{1}{2}\left(\frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}\right),\quad \zeta = \frac{1}{2}\left(\frac{\partial v}{\partial x} - \frac{\partial u}{\partial y}\right)$$

Velocity potential in irrotational motion.

* History of Elasticity, etc., Vol. I., p. 872.

to the theory of structures, to the theory of hydromechanics, to the elastic solid theory of light, and to the theory of crystalline media.

In closing these very inadequate allusions to this intensely practical and abstrusely mathematical science, it is fitting that attention should be called to the magnificent labors of the 'dean of elasticians,' M. Barré de Saint-Venant. It was the object of his life-work to make the theory of elasticity serve the utilitarian purposes of the engineer and at the same time to divest it so far as possible of all empiricism. His epoch-making memoir* of 1853, on the torsion of prisms, is not only a classical treatise from the practical point of view, but one of equal interest and importance in its theoretical aspects. His investigations are everywhere delightfully interesting and instructive to the physicist; and many parts of them are replete, as observed by Kelvin and Tait,† with "astonishing theorems of pure mathematics, such as rarely fall to the lot of those mathematicians who confine themselves to pure analysis or geometry, instead of allowing themselves to be led into the rich and beautiful fields of mathematical truth which lie in the way of physical research." More important still in a didactic sense are his annotated edition of Navier's 'Résistance des Corps Solides,' of 1864, and his annotated edition of the French translation of the 'Theorie der Elasticität fester Körper,' of Clebsch, which appeared in 1883. These monumental works, whose annotations and explanatory notes quite overshadow the text of the original authors, must remain for a long time standard sources of information as to the history, theory, methods and results of this complex subject. The luminous exposition, the penetrating insight into physical relations, and the scientific candor in his criticism of other authors, render the work of Saint-Venant worthy of the highest admiration.

Closely allied to the theory of elasticity, though historically much older, is the science of hydromechanics. The latter is, indeed, included essentially in the former; and probably the great treatises of the next century will merge them under the title of molecular mechanics. It may seem somewhat singular that the mathematical theory of solids should have originated so many centuries later than the theory of fluids; for at first thought, tangible though flexible solids would appear much more susceptible of investigation than mobile liquids and invisible gases. But a little reflection leads one to the conclusion that it was, in fact, much easier to observe the data essential to found a theory of hydromechanics than it was to discover the principles which led to the theory of stress and strain; and the time interval between Archimedes and Galileo may serve perhaps as a rough measure of the relative complexity of hydrostatics and the theory of flexure and torsion of beams. It must not be inferred, however, that the simplicity of the phenomena of fluids in a state of relative rest extends to the phenomena of fluids in a state of relative motion; for the gap that separates hydrostatics from hydrokinetics is one which has not yet been fully bridged even by the aid of the powerful resources of modern mathematics.

The elements of hydrokinetics, with which branch of hydromechanics this sketch is alone concerned, were laid down by Euler about the middle of the last century.* It

* 'Mémoire sur la torsion des prismes,' etc., published in *Mémoires des savants étrangeres*, Tome XIV., 1855.

† Natural Philosophy, 2d ed., Part II., p. 249.

* 'Principes géneraux du mouvement desflui des.' *Histoire de l'Académie de Berlin*, 1755.

'De Principiis motus fluidorum.' *Novi Commentarii Academiæ, Scientiarum Imperialis Petropolitanæ*, Tomus XLV., Pars I., pro anno 1759.

is to him that we owe the equations of motion of a particle of a 'perfect fluid.' This is an ideal fluid, moving without friction, or subject, in technical terminology, to no tangential stress. But while no such fluids exist, it is easily seen that under certain circumstances this assumed condition approaches very closely to the actual condition; and, in accordance with the method of mathematico-physical science in untangling the intricate processes of nature, progress has proceeded by successive steps from the theory of ideal fluids toward a theory of real fluids.

The history of the developments of hydromechanics during this century has been very carefully and completely detailed in the reports to the British Association for the Advancement of Science of Sir George Gabriel Stokes,* in 1846, and of Professor W. M. Hicks,† in 1881 and 1882. And the history of the subject has been brought down to the present time by the address of Professor Hicks before Section A of the British Association for the Advancement of Science in 1895, and by the report‡ of Professor E. W. Brown to Section A of the American Association for the Advancement of Science in 1898. It may suffice here, therefore, to glance rapidly at the salient points which mark the advances from the state of the science as it was left by Lagrange a hundred years ago.

The general problem of the kinetics of a particle of a 'perfect fluid' is easily stated. It is this:* given for any time and for any position of the particle its internal pressure, its density, and its three component velocities, along with the forces to which it is subject from external causes; to find the pressure, density, and velocity components corresponding to any other time and to any other position. There are thus, in general, five unknown quantities requiring as many equations for their determination. The usual six equations of motion, or the equations of d'Alembert, contribute only three to this required number, namely, the three equations of translation of the particle, since the three which specify rotation vanish by reason of the absence of tangential stress. A fourth equation comes from the principle of the conservation of mass, which is expressed by equating the time rate of change of the mass of the particle to zero. This gives what is technically called the equation of continuity. A fifth equation is usually found in the law of compressibility of the fluid considered.†

Now, the equations of rotation, as just stated, refuse to answer the question whether the particles proceed in their

* 'Report on recent researches in hydrodynamics,' Report of British Association for the Advancement of Science for 1846.

† 'Report on recent progress in hydrodynamics,' Reports of British Association for the Advancement of Science for 1881 and 1882.

‡ 'On recent progress towards the solution of problems in hydrodynamics,' Proceedings of American Association for the Advancement of Science for 1898. See also SCIENCE, November 11, 1898.

Reference should be made also to Professor A. E. H. Love's paper 'On recent English researches in vortex-motion,' in the *Mathematische Annalen*, Band XXX., 1887.

* The statement here given is that of the 'historical method,' which seeks to follow a particle of fluid from some initial position to any subsequent position and to specify its changes of pressure, density and speed. What is known as the 'statistical method,' on the other hand, directs attention to some fixed volume in the fluid and specifies what takes place in that volume as time goes on.

† The five equations in question are

$$\frac{du}{dt}=X-\frac{1}{\rho}\frac{\partial p}{\partial x},\qquad \frac{d(V\rho)}{dt}=0,$$
$$\frac{dv}{dt}=Y-\frac{1}{\rho}\frac{\partial p}{\partial y},$$
$$\frac{dw}{dt}=Z-\frac{1}{\rho}\frac{\partial p}{\partial z},\qquad p=f(\rho);$$

in which p is the pressure and ρ is the density at the centroid (x, y, z) of the particles; V is its volume; u, v, w are its component velocities; and X, Y, Z are the force components per unit mass arising from external causes.

orbits without rotation or whether they undergo rotation along with their motion of translation. This was a critical question, for the failure to press and to answer it seems to have retarded progress for nearly half a century. Lagrange, and after him Cauchy and Poisson, knew that under certain conditions* the differential equations of motion are integrable, but they do not appear to have understood the physical meaning of these conditions. It remained for Sir George Gabriel Stokes to show that the Lagrangian conditions of integrability correspond to the case of no molecular rotation, thus clearly distinguishing the two characteristic types of what we now call irrotational and rotational motion.† Such was the great step made by Stokes in 1845; and it furnishes a forcible illustration of the importance, in applied mathematics, of attending to the physical meaning of every symbol and every combination of symbols.

Thirteen years later came the remarkable memoir of Helmholtz (1821–1894) on the integrals of the equations of hydrokinetics for the case of rotational, or vortex, motion.‡ This memoir is alike wonderful for the directness with which the mathematical argument proceeds to its conclusions and for the clearness of insight it affords of the physical phenomena discussed. In short, it opened up a new realm and supplied the results, concepts, and methods which led the way to the important advances in the science made during the past three decades.

Another powerful impulse was given to hydrokinetics, and to all other branches of mathematical physics as well, by Kelvin and Tait's Natural Philosophy—the Principia of the nineteenth century—the first edition of which appeared in 1867. From this great work have sprung most of the ideas and methods appertaining to the theory of motion of solids in fluids, a theory which has yielded many interesting and surprising results through the researches of Kirchhoff, Clebsch, Bjerknes, Greenhill, Lamb and others. Of prime importance also are the numerous contributions of Lord Kelvin to other branches of hydrokinetics, and particularly to the theory of rotational motion.* In fact, every department of the entire science of hydromechanics, from the preliminary concepts up to his vortex atom theory of matter, has been illuminated and extended by his unrivalled fertility.

When we turn to the more intricate branch of the subject which deals with the motion of viscous fluids, or with the motion of solids in such fluids, it appears that the progress of the century is less marked, but still very noteworthy. This branch is closely related to the theory of elasticity, and goes back naturally to the early researches of Navier, Poisson and Saint-Venant; but the revival of interest in this, as well as in the less intricate branch of the subject, seems to date from the fruitful memoir† of Stokes, of 1845, and from his report to the British Association for the Advancement of Science of 1846. Since then many interesting and useful problems relative to the flow of viscous fluids and to

* That is, when $udx + vdy + wdz$ is a perfect differential, u, v, w being velocity components; or, when

$$\frac{\partial w}{\partial y} - \frac{\partial v}{\partial z}, \quad \frac{\partial u}{\partial z} - \frac{\partial w}{\partial x}, \quad \frac{\partial v}{\partial x} - \frac{\partial u}{\partial x},$$

which are the doubles of the components of molecular rotation, vanish, these latter being the conditions for the existence of a velocity potential.

† This discovery of Stokes was announced in his fundamental paper 'On the theories of internal friction of fluids in motion, and of the equilibrium and motion of elastic solids,' *Transactions of the Cambridge Philosophical Society*, Vol. VIII. Reprinted also in his Mathematical and Physical Papers, Vol. I.

‡ "Ueber Integrale der hydrodynamischen Gleichungen, welche den Wirbelbewegungen entsprechen," *Crelle's Journal für die reine und angewandte Mathematik*, 1858.

* 'On vortex motion,' 1867. *Transactions of the Royal Society of Edinburgh*, Vol. XXV.

† Cited above.

the motion of solids in such media, have been successfully worked out to results which agree fairly well with experiment. But on the whole, notwithstanding the searching investigations in this field of Stokes, Maxwell, Helmholtz, Boussinesq, Meyer, Oberbeck, and many others, it must be said that difficulties, both in theory and in experiment, of a formidable character remain to be surmounted.*

Of all branches of hydromechanics there is none of so great practical utility and of such widely popular interest as the theory of tides and waves. These phenomena of the sea are appreciable to the most casual observer; and there has been no lack of impressive descriptions of their effects from the days of Curtius Rufus down to the present time. The mechanical theory of tides and waves is, however, a distinctly modern development whose perfection must be credited to the labors of the mathematicians of the present century.†

Here, again, progress is measured from the advanced position occupied by Laplace, who was the first to attempt a solution of the tidal problem on hydrokinetic principles. After the fundamental contributions of Laplace, contained in the second and fifth volumes of the 'Mécanique Céleste,' the next decisive advance was that made by Sir George Airy (1801–1892), in his article on tides and waves, which appeared in the Encyclopædia Metropolitana in 1842. A quarter of a century later came the renaissance, started undoubtedly by the great memoir of Helmholtz and by the Natural Philosophy of Kelvin and Tait, along with Lord Kelvin's inspiring communications on almost every phase of wave and tidal problems to scientific societies and journals. Then followed the decided theoretical improvements in tidal theory of Professor William Ferrel,* particularly in the development of the tide generating potential and in the determination of the effects of friction. And a little later there appeared the novel investigations of Professor G. H. Darwin, who, in addition to furnishing a complete practical treatment of terrestrial tides,† has extended tidal theory to the solar system and thrown an instructive light on the evolutionary processes whence the planets and their satellites have emerged and through which they are destined to pass in the future.‡

As we reflect on the progress which has been thus summarily, and quite inadequately outlined, it will appear that the mathematicians of the nineteenth century have contributed a splendid aggregate of permanent accessions to knowledge in the domain of the more exact of the physical sciences. And as we turn from the certain past to the less certain future, one is prone to conjecture whether this brilliant progress is to continue, and, if so, what part the

*An extremely interesting method of experimental investigation has been recently applied with success by Professor Hele-Shaw. See a paper by him on 'Stream-line motion of a viscous film,' and an accompanying paper by Sir G. G. Stokes on 'Mathematical proof of the identity of the stream-lines obtained by means of a viscous film with those of a perfect fluid moving in two dimensions.' Report of British Association for the Advancement of Science for 1898.

† An excellent summary of the history and theory of tides, and of methods of observing and predicting them, is given by Dr. Rollin A. Harris in his 'Manual of Tides,' published as Appendices 8 and 9 of the Report of the U. S. Coast and Geodetic Survey for 1897.

* 'Tidal Researches.' Appendix to Report of U. S. Coast and Geodetic Survey for 1874, Washington, 1874.

† In article on tides in Encyclopædia Britannica, 9th edition.

‡ Darwin's investigations are published in a series of papers in the *Philosophical Transactions of the Royal Society of London*, Parts I., II., 1879; Part II., 1880; Part II., 1881; Part I., 1882. They are republished in part in Appendix G, Thomson and Tait's Natural Philosophy, 2d edition. See also the capital semi-poplar work, 'The Tides and Kindred Phenomena in the Solar System,' by G. H. Darwin Boston and New York, Houghton, Mifflin & Co., 1889.

American Mathematical Society may play in promoting further advances. With respect to these enquiries I should be loath to hazard a prediction or to offer advice. But there appears to be no reason for entertaining other than optimistic expectations. The routes along which exploration may proceed are numerous and attractive. We have only to follow the example set by Laplace, Poisson, Green, Gauss, Maxwell, Kirchhoff, Saint-Venant, Helmholtz, and their eminent contemporaries and successors. In commending the works of these great masters to the younger members especially of the American Mathematical Society, I would not be understood as urging the cultivation of pure mathematics less, but rather as suggesting the pursuit of applied mathematics more. The same sort of fidelity to research and the same sort of genius for infinite industry which enabled those masters to accomplish the grand results of the nineteenth century, may be confidently expected to achieve equally grand results in the twentieth century.

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CRUISE OF THE ALBATROSS.

II.

THE following letter from Dr. Agassiz, dated Papeete Harbor, Tahiti Island, November 6, 1899, has been received by the United States Fish Commission and is here published by courtesy of Commissioner Bowers.

During our stay in Papeete some time was spent in examining that part of the barrier reef of Tahiti which had been surveyed by the *Challenger*. We found the condition of the outer slope of the reef quite different from its description as given in the *Challenger* narrative. The growing corals were comparatively few in number, and the outer slope showed nothing but a mass of dead corals and dead coral bowlders beyond 16 or 17 fathoms, few living corals being observed beyond 10 to 12 fathoms.

We also made an expedition to Point Venus, to determine, if possible, the rate of growth of the corals on Dolphin Bank from the marks which had been placed on Point Venus by Wilkes, in 1839, and by MM. Le Clerk and de Bénazé, of the French navy, in 1869. We found the stones and marks as described, but, in view of the nature and condition of Dolphin Bank, did not think it worth while to make a careful survey, as Captain Moser had intended to do. On examining Dolphin Bank in the steam launch I was greatly surprised to find that there were but few corals growing on it. I could see nothing but sparsely scattered heads, none larger than my fist, the top of the bank being entirely covered by nullipores. We sounded across the bank in all possible directions and examined it thoroughly, and at the stage of water at which we sounded, found about 18 inches difference from the soundings indicated by the charts. It is also greatly to be regretted that Dolphin Bank was not examined, neither in 1839 nor in 1869, and notes made of what species of corals, if any, were growing on its surface; for an excellent opportunity has been lost to determine the growth of corals during a period of 60 years. The choice of this bank as a standard to determine the growth of corals was unfortunate, as it is in the midst of an area comparatively free from corals.

Extensive collections have been made at Papeete during our visit by the naturalists of the *Albatross*.

After refitting and coaling here, we left on the 5th of October for a cruise in the Paumotus.

We steamed for Makatea, which we had visited on our way to Tahiti, and not only examined the island more in detail, but took a number of photographs of the cliffs on the east side, which, on our first trip, we passed late in the afternoon. We crossed the island from west to east, the path leading down from the summit of the cliffs bordering the island into a sink at least 40 to 50 feet lower than the rim of either face of the island. The sink occupies a little more than one-third the length of the island. It is deeper at its southern extremity, where it is said to be 75 to 100 feet below the rim of the adjoining cliffs.

It is difficult to determine if this sink is the remnant of the former lagoon of the island, or of a sound formed during its elevation; or if it has been formed by the action of rain and atmospheric agencies. The amount of denudation and erosion to which this island has been subjected is very great, as is clearly indicated by the small cañons, pinnacles, and walls of limestone, as well as by the crevasses which occur in the surface of the basin in all directions. The extent to which this action has penetrated into the mass of the island is also plainly shown by the great number of caverns which crop out at all levels along the sea face of the cliffs, some of which are of great height, and extend as long galleries into the interior of the island. It is, of course, difficult, in the face of this extensive denudation and erosion, to state positively what may be part of the ancient lagoon, or sound, and what has been carried away by atmospheric and other agencies since the elevation of the island. At the south end of the island, which is lower than the northern part, there are only two distinct terraces, while at the northern end four terraces can be traced. The southern extremity, however, is still higher than the deepest part of the central sink of the island.

From Makatea, we visited Niau, Apataki, Tikei, Fakarava, Anaa, Tahanea, Raroia, Takume, Makemo, Tekokota, Hikueru, Marokau, Hao, Aki-Aki, Nukutavake, going as far east as Pinaki, when we turned westward again to Nukutipipi.

On arriving at Pinaki we decided to give up the exploration of the eastern extremity of the Paumotus, and not to make our contemplated visit to the Gambier Islands, our time having been greatly curtailed by delays at Fakarava and Makemo, from bad weather and the non-arrival of our coal supply. We therefore reluctantly turned westward again and made for the Gloucester Islands. These, as well as Hereheretue, proved most interesting; they formed, as it were, an epitome of what we had seen on a gigantic scale in the larger atolls of the western and central Paumotus. We could see at a glance in such small atolls as Nukutipipi and Anu-Anurunga, the connection between structural features which, in an atoll 40 miles in length and from 10 to 15 miles in width, it was often difficult to determine.

Except at Nukutavake we found no village in which the habits of the natives had not been more or less modified by civilization. The Paumotu Islanders have practically given up building their own houses; they use European models and their roofs are composed in great part of galvanized iron. There are also but few of the original native canoes to be seen. In a few years all traces of their customs and crafts will have disappeared.

We also steamed by Kauehi, Tænga and Tuanaka. We anchored in Fakarava and Makemo lagoons, spending a number of days in both these atolls. We usually timed our visits to the islands where we could not anchor so as to spend the day, or the greater part of the day, at these atolls, making our passages at night, and sounding whenever practicable on the way.

After leaving Tahiti we made over 100 soundings. These have shown in a general way that the western islands are probably all on a great plateau connected perhaps by the 800-fathom line; that such islands as Anaa are probably on spurs or independent smaller plateau, separated from the main plateau by somewhat deeper water. The same may be the condition of Raroia and Takume and of Hao and Amanu, while such smaller and isolated peaks as Tikei, Aki-Aki, Nukutavake, and Pinaki, as well as the Gloucester Islands, rise from greater depths and are isolated peaks. At any rate, these soundings indicate, as do the soundings off the Fijis, that atolls do not necessarily rise from very great depths, and that in this characteristic atoll district, atolls are found, it is true, with steep slopes, but rising from moderate depths. The slopes of these atolls would probably resemble in every respect the slope of the elevated coralliferous limestone islands characteristic of the Lau Group in Fiji.

The deepest sounding among the Paumotus was on the line to the northward of Hereheretue in the direction of Mahetia, where we found a depth of 2524 fathoms, and a continuation of the red clay characterizing the soundings since we left Pinaki. In nearly all the soundings among the Paumotus, even at moderate depths not far from the atolls, we brought up manganese particles or small manganese nodules. The last haul, made in deep water on the way from Hereheretue, in 2440 fathoms, brought up at least half a ton of manganese nodules, the bottom being red clay.

We have now steamed about 2500 miles among the Paumotus, and although we had not the advantage of the accurate surveys of the English hydrographic charts, which made the exploration of Fiji so easy, yet from the structure of these atolls it was a comparatively simple task, by steaming around the islands and landing wherever practicable, to get a fairly good idea of their structure. We have seen nothing in this more extended examination of the group tending to show that there has anywhere been subsidence. On the contrary, the condition of the islands of the Paumotus cannot, it seems to me, be explained on any other theory except that they have been formed in an area of elevation; an area of elevation extending from Matahiva on the west to Pinaki in the east, and from the Gloucester Islands on the south to Tikei in the north, although the islands in the line of Mangareva to Tahiti are separated from the other Paumotus by a deep channel, nearly 200 miles wide and more than 2400 fathoms in depth, with scattered islets and atolls extending from Mangareva to Pinaki, and northward to Serle Island and beyond, islands which are not connected with the extensive plateau upon which the greater number of the Paumotu Islands to the westward of Hao rise.

All the islands we have examined are, without exception, formed of tertiary coralliferous limestone which has been elevated to a greater or less extent above the level of the sea, and then planed down by atmospheric agencies and submarine erosion, the greatest elevation being at Makatea (about 230 feet), and at Niau, where the tertiary coralliferous limestone does not rise to a greater height than 20 feet. At Rairoa it was 15 to 16 feet high. At other islands it could be traced only as forming the shore platform, from 50 to 150 feet wide, which forms the outer face of the Paumotus, and is so characteristic a feature of the atolls of the group. In other parts the old ledge could be traced cropping up in the interior of the outer rim, or in the open cuts connecting the lagoon with the outer sea face of the atolls. Everywhere the space between the outcropping of the old ledge, as I will call the tertiary coralliferous limestone, was filled with beach rock, or a pudding stone, or with a breccia or conglomerate of coralliferous material consisting in part of fragments of the old ledge and of fragments of recent corals and shells cemented together.

The appearance of the old ledge and of the modern reef rock is so strikingly different that it is very simple to distinguish the two, even when only comparatively small fragments are found.

We did not find in the Paumotus, as in Fiji, all possible stages of denudation and of submarine erosion between islands like Vatu Vara, Niau, Kambara, Fulanga, Ongea, Oneata, Ngele Levu, and Weilangilala, and atolls with a mere ring or surf to indicate their existence.

In the Paumotus the islands have been elevated to a very moderate height and probably to nearly the same height, for the old ledge forming the base of the modern structure is found exposed nearly everywhere at about low-water when it cannot be traced at a slightly greater elevation. This would readily account for the nearly uniform height of the islands throughout the group.

But there is another element which comes into play in this group, and has an important part in shaping the ultimate condition of these atolls. At the Fijis we have seen the submarine erosion continue until there is little left of many of the atolls beyond the merest small islet or rock to indicate its structure. In the Paumotus, in the great atolls which are evidently only the exposed summits of parts of ridges or spurs of an extensive tertiary coralliferous limestone bed, the rim of the atoll is, after having been denuded to the level of the sea, again built up from the material of its two faces which is thrown up on the wide reef flats both from the sea face and from the lagoon side. We do not find in the Fijis such huge reef shelves to supply such masses of material from the breaking up of the outer and inner edges of the tertiary limestone platforms, in addition to the fragments of recent corals growing upon the flat and its edges, which, when dead, are thrown up and formed into shingle and sand to form a pudding stone, or a conglomerate, or breccia, with the fragments of the old ledge on the top of the reef flats.

This pudding stone, or beach rock, is found on all the reef flats of the islands of the group. It forms great bars, at right angles usually to the shore-line, and upon the sea-face of these bars is thrown up coral shingle, both old and recent, which builds up short reaches of beaches separated by wide flats through which the sea rushes at high water, or merely covers the flats at low tide; while on the lagoon side of the wide reef flats a similar process is going on, throwing up finer sand among the beach-rock bars and along their sides, and thus building up, little by little, at first small sand bars, then larger bars, or islets, at right angles to the shore-line, and as they become larger by accretions from both sides, they finally form an island from 1000 to 1200 feet long, according to the width of the reef flat, extending from the lagoon edge of the flat to the sea face of the atoll. The sand bars, little by little, become covered with vegetation, and at some stages of tide appear like islands and islets situated a considerable distance within the lagoon. Whenever the material supplied both from the lagoon side and from the sea face is very abundant, the land ring becomes more or less solid, the islets become consolidated into islands, separated by narrow or wider cuts, until finally they form the larger islands which seem at first glance to form continuous land along the rim of the lagoon, but which are often seen to be separated according to local conditions by narrow cuts, which finally allow no water to pass through and merely indicate the former separation of the various parts of the land.

In the lagoons of atolls of such great length as some of these of the Paumotus, like Rairoa, Fakarava, Makemo and Hao, which are between 30 and 40 miles long, and others of less dimensions, considerable sea rises under the prevailing trades. The sea and wind generally follow the trend of the shores, both in the lagoon and along the sea face, so that the bars of beach rock act like buttresses and collect material at their inner and outer extremities, forming the sand bars and islets which eventually become the land rim of the lagoon. When the material is not from local causes very abundant, or is washed out over the flats, there are fewer islands, and often these are but mere islets or bars for long reaches of the shore, forming the characteristic weather faces of many of the lagoons.

Many of the lagoons are filled with shoals or ledges awash or a few feet above the sea-level. These shoals are parts of the old ledge which have not as yet been eroded, and the disintegration of which has gone far to supply material for the land of the outer rims of the atolls. In Fakarava there were no less than 36 islands and islets and ledges, parts of a former great flat, now broken up, existing parallel to the outer reef flat about four miles in the lagoon. Similar reef flats exist in Tahanea, where they form a secondary lagoon with two to three fathoms of water, extending nearly the whole length of the western face of the atoll. There are several large islands on this flat, and at high water they would appear as the islands and islets of Fakarava do, as disconnected and planted in the lagoon itself. A secondary lagoon also exists in Ravahere and Anaa; in both these atolls the reef flat extends across one extremity of the lagoon and does not run parallel to the longer shore-line of the atoll.

The lagoons of these atolls have a general depth of 13 to 20 fathoms. In some cases they are, as is stated, somewhat deeper (but there are no measurements), the greater depths being 30 fathoms or more, being due to orogenic conditions. Some of the atolls are quite shallow, as at Matahiva as well as Pinaki, where the lagoon is not more than two to three fathoms, and Takume, where it is from five to six fathoms deep. Some of the smaller islets we visited, among which are Tekei, Aki-Aki and Nukutavake, have no lagoons. The former has a shallow sink in which fresh water collects, but the rim is only very slightly higher than the interior. The last two islets are apparently depressed in the center, three to four feet below the outer bank of sand which forms the rim (about 10 to 12 feet high) of the basin of the island. I was at first inclined to look upon these islands as examples of islands which had been cut down to the level of the sea and subsequently been built up by beach rock and sand in the manner described above. The existence of extensive sand dunes on two sides of the island at Pinaki, and of a large dune (estimated to be 35 feet high) on the south shore of Nukutavake, seems to indicate the possibility of there having been a shallow lagoon occupying the center of Aki-Aki and of Nukutavake, and that these lagoons were gradually filled by the sand dunes, much as Pinaki is filling now.

At Pinaki (Whitsunday Island), there is no doubt but that the lagoon is rapidly filling from the sand blown in by the dunes. They are from 12 to 15 feet high and are forcing their way in towards the lagoon, killing the pandanus and whatever vegetation there is growing on the land rim of the lagoon. The dunes have probably filled also a second entrance to the lagoon, indicated now only by a somewhat lower level of the land rim. Mr. Moore and Mr. Townsend, who went ashore at Pinaki, report that the lagoon is not more than three fathoms deep; they could wade over the greater part of it. Mr. Alexander counted no less than 116 islets in this small lagoon —less than a mile in diameter—islets formed of masses of dead Tridacna shells thrown up on ledge rock, on the slopes of which grew madrepores. The bottom of the lagoon is covered by Tridacna and masses of a species of Arca live near the edge, the intervening spaces being filled with nullipores. The entrance to the lagoon is perhaps 150 feet wide, and there is a cut through the beach rock covering the old ledge, giving access to the sea into the lagoon at certain stages of the tide. The water in the lagoon is quite warm.

At Pinaki, as at other atolls and islets to the eastward, there are fewer cocoanuts than on the westward atolls, and the vegetation consists in great part of pandanus and puteau trees and the usual coral reef vegetation of the Paumotus and Fijis.

The only atoll we have seen, the lagoon of which is entirely shut off from the sea, is Niau. In this case the old ledge forming the rim of the land, which surrounds the nearly circular lagoon, is about a third of a mile in width, and sufficiently high, 15 to 20 feet, to prevent any sea from having access to it except in case of a cyclone, as that of 1878, when the sea washed into the lagoon. The lagoon is shallow, of an average depth of about three fathoms, the deeper parts perhaps five. The water is brackish, of a density of 1.0216 at 28 degrees C. There are no corals living in it, but a species of mullet is found, as well as many marine shells, which, like those in the lagoons of San Salvador, in the Bahamas, are of diminutive size compared to their representatives living outside. The floor of the lagoon is covered with algæ. The lagoon has probably a slight connection with the sea, the water percolating through the limestone ring separating it from the outer reef flat. It is very difficult in this case to decide whether this lagoon has been gradually filled up after elevation or whether it is merely a sink on a more or less uneven limestone surface.

Dana and the other writers on coral reefs mention a great number of lagoons as being absolutely shut off from the sea. I take it these statements are due to their descriptions being taken from charts, many of which (as in the case of the Paumotus) are very defective. For nothing is easier than to pass at a short distance by the wide and narrow cuts which give in so many places the freest access to the sea to the interior of the lagoons, and described as closed because they have no boat passages. I could mention as instances of such lagoons those of the atolls of Takume, Hikueru, Anaa, etc., which may be said to be closed, yet into which a huge volume of water is poured at every tide over low parts of the encircling reef flats.

The character of the coral reefs of the Paumotus is very different from that of other coral reef regions I have seen. Nowhere have I seen such a small number of genera, so many small species, and such stunted development of the corals. None of the great heads of the genera so characteristic of the West Indian regions, or of the great barrier reef of Australia, are to be seen; with the exception of a couple of species of alcyonaria they are absent, so far as our experience shows, and there are but few sponges and gorgonians to be found among the corals. The bathymetrical limit of the reef-building corals seems to be about 20 to 22 fathoms, but nowhere have I seen such extraordinary development of incrusting nullipores as on the sea edge of the shore platforms of some of the Paumotu atolls, where they build up to a height often four feet to form the outer edge of the secondary barrier reef so frequently seen along the reef faces of the Paumotus.

On the 4th of November we were well on our way to Mehitia, the easternmost of the Society Islands, the account of which will be included in my next letter giving the results of our examination of the Society Islands.

We have taken a large number of photographs to illustrate the structure and mode of formation of the Paumotu atolls. Mr. Mayer has devoted much time to the drawing of the medusæ collected.

Judging from the temperature taken at various points, 40° F. seems to be found quite generally at about 500 fathoms depth.

We made a number of surface hauls, as well as intermediate hauls, with the townets, but obtained very little animal life. The poverty of the surface pelagic life, and down to 300 fathoms, is remarkable. I do not think I have ever sailed over so extensive an area as that of the Paumotus and observed so little surface life; on calm days, under the most favorable conditions, nothing could be seen with the naked eye, and at night there was little or no phosphorescence. Inside the lagoons our hauls were equally barren.

The same paucity of animal life seemed to extend to the deep-water fauna. All the hauls we made off the islands, in from 600 to 1000 fathoms, usually the most productive area of a sea slope, brought nothing, or so little that we came to grudge the time spent in trawling on the bottom, as well as towing on the surface or near it, a great contrast to the conditions of the Atlantic in similar latitudes, and very different from our anticipations. For these reasons no attempt has thus far been made to make a trial of the deep-sea pump while in such unproductive areas, and unfortunately while we were in the region of the equatorial current the weather conditions were not suited for a trial of the apparatus.

We expect now to coal and refit, and to leave for Suva via Tonga on the 15th of this month. A. Agassiz.

THE TWELFTH ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA.

I.

The Geological Society of America convened at 10 a. m., Wednesday, December 27th, in the large lecture room of Columbia University, Washington, D. C. President B. K. Emerson called the meeting to order and Dr. G. K. Gilbert delivered an address of welcome, to which the President responded. The following officers were then declared elected for the ensuing year:

President: George M. Dawson, Ottawa, Ont.; *First Vice-President:* Charles D. Walcott, Washington, D. C.; *Second Vice-President:* N. H. Winchell, Minneapolis, Minn.; *Secretary:* H. L. Fairchild, Rochester, N. Y.; *Treasurer:* I. C. White, Morgantown, W. Va.; *Editor:* J. Stanley-Brown, Washington, D. C.; *Librarian:* H. P. Cushing, Cleveland, O.; *Councillors:* W. B. Clark, Baltimore, Md., and A. C. Lawson, Berkeley, Calif.

The following new Fellows were also announced as having received election:

Irving Prescott Bishop, 109 Norwood Avenue, Buffalo, N. Y., Professor of Natural Science, State Normal and Training School; Emilo Böse, Ph.D. (University of Munich, 1893), Calle del Paseo Nuevo No. 2, Mexico, D. F., Geologist of the Instituto Geologico de Mexico; Arthur Starr Eakle, B.S. (Cornell, 1892), Ph.D. (Munich, 1896), University Museum, Cambridge, Mass., Instructor in Mineralogy and Petrography, Harvard University; August Frederick Foerste, A.B. (Denison, 1887), A.M., Ph.D. (Harvard, 1888, 1890); John Flesher Newsom, A.B. (University, Indiana, 1891), A.M. (Stanford, 1892), Stanford University, Calif., Associate Professor of Metallurgy and Mining, Stanford University; Samuel Lewis Penfield, Ph.B., M.A. (Yale, 1877, 1896), New Haven, Conn., Professor of Mineralogy, Sheffield Scientific School of Yale University; Charles Henry Richardson, A.B., A.M., Ph.D. (Dartmouth, 1892, 1895, 1898), Hanover, N. H., Instructor in Chemistry and Mineralogy, Dartmouth College; Arthur Brown Willmott, B.A., B.Sc. (Victoria University, Toronto, 1887), M.A. (Harvard, 1891), Toronto, Canada, Professor of Geology and Chemistry, McMaster University.

During the year the Society has lost by death four of its most distinguished Fellows, of whom two, Sir J. William Dawson and Edward Orton, have been presidents. The others were O. C. Marsh and Oliver Marcy. Memorials were read of all but Professor Marsh, whose biographer, Professor C. E. Beecher, was absent, and had failed to send his manuscript. Extemporaneous remarks were made after the reading of each of the memorials, and they were often marked by deep feeling, as one after another of the former students of the departed scientists paid his tribute to his old teacher and friend. The first paper was then read as follows:

Physiographic terminology with special reference to land forms. By W. M. DAVIS, Cambridge, Mass.

The paper embraced a critical discussion and a definition of terms, mostly suggested within the last thirty years, for the description of land forms. The terms cycle, base-level and grade were considered in detail.

The general principle was advocated that terms should be based on observation and should express its results. The geographical cycle was urged as the basis. Instead of the old conceptions of destructional and constructional; initial, sequential and ultimate were suggested. It was urged that for 'base-level' as applied to the limiting conditions of the development of a river 'graded slope' be substituted—as base-level has now a variety of meanings. Other terms involving the syllables 'sequent,' such as consequent, obsequent, insequent, subsequent, etc., were suggested and defined. In discussion B. K. Emerson referred to the difficulty of remembering the distinctions in meaning among so many similar terms, a remark that struck a sympathetic chord in the minds of all teachers present.

Camas Land, a valley remnant. By GEO. OTIS SMITH and GEO. CARROLL CURTIS, Washington, D. C., and Boston, Mass.

A description was given of the remnant of an old valley on the eastern slope of the Cascade Mountains, in Washington (Mt. Stuart quadrangle). Camas Land owes its preservation above the circumdenudation to an intrusive sheet of diabase. A relief model of Camas Land was exhibited which made clear to all present the peculiar phenomena of the region and the rearrangement of the drainage. Discussion by W. M. Davis and M. R. Campbell ensued, which, however, would require the model to be intelligible to one not present.

Some coast migrations, Southern California. By BAILEY WILLIS, Washington, D. C.

The section of the California coast described extends from Point Sur to Piedras Blancas, between Monterey and San Luis Obispo. Formations constituting the Santa Lucia Range of the Coast Ranges were described, their relations to each other stated, and the corresponding migrations of the Pacific Coast were indicated with probability. A review of the observations of Fairbanks was presented.

It was shown that the oldest rocks constitute a series of metamorphic schists and that on these rest the Jurassic, Cretaceous, Miocene and Pliocene series. The schists are intruded by granite. Five thousand feet above the Pacific the Miocene beds are met dipping eastward and thinning out in that direction. This indicates a great land area which must have existed in the Miocene, where now is the Pacific ocean; 3000 feet above the sea, folded Pliocene strata occur. There are, therefore, two submergences indicated and great elevation and disturbances in comparatively recent geologic time.

Submerged forest of the Columbia River. By G. K. GILBERT, Washington, D. C.

At the Cascades the Columbia river flows over a natural dam of rock fragments. In the pond above stand sound stumps of Douglas spruce. Of various explanations proposed that first suggested by Lewis and Clark and repeated by Gibbs and Newberry accords best with the facts. The river was dammed by a land slide from the north not less than 350 years ago.

The speaker reviewed the explanations

of other observers and the Indian legends. He showed the general topography and geology by means of maps, and explained his estimate of the lapse of time by the rings in the stumps of trees which had grown on the landslide. There is also a river terrace about 100 feet above the present water level. The landslide therefore ponded the river and drowned the trees standing above it. In discussion J. A. Holmes cited cypress trees, in good preservation, 20 feet below the bottoms of rivers in North Carolina, and G. B. Shattuck spoke of similar cases in Maryland in the Pleistocene.

Physiographic development of the Washington region. By N. H. Darton, Washington, D. C.

A general sketch was presented, illustrated by maps and photographic illustrations, and intended to give visiting geologists an outline of the principal features of the Mesozoic to recent geology.

The paper was not meant for publication, but it served to set before the Society an excellent idea of the geological formations near Washington and their physiographic development.

Erosion forms in the Harney Peak District, Black Hills, South Dakota. By Edmund Otis Hovey, New York City.

The paper consisted of the exhibition of about ten lantern slides, showing the peculiar forms produced by erosion in the schists and pegmatites in the Harney Peak District in the Black Hills of South Dakota.

The slides illustrated the curiously sheeted and jointed granite which leads to the production of very rough topography. Pictures of the large spodumene crystals at the Harney Peak tin mines were also thrown upon the screen.

In discussion President Emerson compared the spodumenes with those of Massachusetts. S. F. Emmons described the occurrence of the spodumenes in pegmatites. I. C. Russell inquired if there were evidences of glaciation in the hills; Mr. Hovey replied, no. A. C. Spencer inquired if the Sylvan Lake was a rock-basin. This was likewise answered in the negative.

Topographic features of Ohio. By W. G. Tight, Granville, O.

The general topographic features of the different sections of the State were discussed and an attempt was made to show the reasons for the different types. The paper was illustrated with lantern views.

The author remarked the paucity of information about the physiography of the State in general. He divided it into three areas: the northwestern, within the limits of the glacial ice; the border, a belt along the terminal moraine; and the southeastern, outside the drift. The readjustments of drainage and the various topographic forms were admirably illustrated. In discussion M. R. Campbell inquired if there was good evidence of peneplains in the southeast; the author replied that there was some but that it was not conclusive. I. C. White discussed the general directions of the drainage.

Drainage modifications in Southeastern Ohio. By W. G. Tight, Granville, Ohio.

The changes in drainage of the region north of the Ohio river and between the lower Muskingum and the lower Scioto have been very great. The lower Muskingum, south of Zanesville, is shown to be a composite stream made up of sections of four preglacial streams which crossed the course of the present Muskingum. These four streams united in what is now the Little Hocking basin, and the main line of preglacial drainage extended across the present Hocking river, which is also shown to be composed of sections of several preglacial streams, into the basin of Raccoon creek and across this basin into that of the Scioto river below Chillicothe. Several of the tributaries of this preglacial river were also described.

The paper gave a very graphic conception of the rearrangements which were brought about by the continental ice sheet, changing the outlet of the river system from the Great Lakes to the Mississippi. In discussion M. R. Campbell brought up the Teazes valley and the changes in the Big Kanawha, and the presence of silt in the former. W. G. Tight then described the area covered by silt and referred the readjustment of the drainage to the obstruction which it presented. The silting was explained by some barrier far to the westward. I. C. White referred to his early description of the valley, and urged the danger of mistaking, for cols, narrows in the Ohio and other rivers produced by the crossing of some hard stratum. The author replied that he had sought to guard against this.

The landslides of the Rico Mountains, Colorado. By WHITMAN CROSS, Washington, D. C.

The Rico Mountains, in southwestern Colorado, are due to the erosion of a local domatic uplift. The sedimentary formations affected embrace the Algonkian, Devonian, Carboniferous, Permo-Carboniferous, Juratrias and Cretaceous. Many intrusive dikes, sheets and small laccoliths of diorite—or monzonite—porphyry occur in this complex. A large monzonite stock penetrates all rocks above mentioned. Intense and complicated faulting has taken place in the heart of the uplift, and there has been a great amount of mineralization, forming argentiferous ore bodies of many types.

Landslides, occurring in a recent geological epoch, are very prominent features of the local geology. These landslide areas were described, the relation of the phenomena to other elements of the geological history were discussed, and hypotheses of their origin set forth.

The landslides are limited to the central portion of the domatic uplift. No apparent connection can be traced between the structure and the slides, nor are they present in the region of greatest faulting. The speaker finally concluded that they were connected with deep, interior vulcanism, transmitted through the intruded stock of monzonite.

J. B. Woodworth mentioned similar cases in southwestern Montana, where water-bearing beds caused the slipping. W. M. Davis mentioned Alpine cases where glacial erosion had removed the support. Dr. Cross said there was no glaciation at Rico. W. H. Niles also referred to Alpine cases. Geo. Otis Smith mentioned similar cases in the Stewart mountains, Oregon, where, of all the rocks present, the granite is alone unaffected.

A recent fault scarp in the Lepini Mountains, Italy. By W. M. DAVIS, Cambridge, Mass.

The Lepini mountain group is a submaturely dissected block of cretaceous strata, 40 miles S. E. of Rome. Recent movement on the line of a tertiary fault has produced a well-defined scarp in places 100–200 feet in height and traceable five miles or more along the northeastern base.

The paper was finely illustrated by the lantern and the truncations of fan-like projections of rock called rock-fans were well shown. There was no discussion. The reading of the paper closed the first day's proceedings.

On Wednesday evening the President, Professor B. K. Emerson, delivered his presidential address upon 'The Tetrahedral Earth and the Zone of the Intercontinental Seas,' before a large gathering of the Society and their friends. It will appear in another number of SCIENCE.

The Society convened in business session Thursday morning at 9.30 o'clock. The report of the Council was submitted and approved. Reports were received from the photographic committee which shows that a collection of over 1900 views has been made. The committee then resigned and N. H. Darton was elected a committee of one to have charge of the matter. A motion was passed approving of the organization of a Cordilleran Section to embrace the members living on the Pacific coast, who by reason of distance cannot meet with the Society, and a telegram of greeting was sent to them in their first session.

The report of the Council showed the Society to be in a very prosperous condition. There are 239 Fellows, besides the 8 elected at this meeting. The Society has an invested fund of $5,000, and on account of an unavoidable delay in issuing Vol. X, had also a balance, December 1st, of $3,030.02. The Society is, however, very anxious and ambitious to increase its invested funds in order that the income may admit of the suitable illustration of papers.

Deposits of calcareous marl in Michigan. By Israel C. Russell, Ann Arbor, Mich.

A large number of lakes and swamps in the southern Peninsula of Michigan have been found to contain deposits of calcareous marl suitable for the manufacture of Portland cement. The marl is composed in part of shells, but is mainly a chemical precipitate and is still being deposited. The better grades contain from 80 to 95 per cent. of calcium carbonate. Several large cement works have already been established and others are contemplated. The supply of marls is practically inexhaustible and Michigan can easily take a leading place in the Portland cement industry.

The precipitation of the calcareous matter is probably due to the fact that calcium carbonate is more soluble in cold water than in warm, and as the lakes are fed by springs, the waters rise in temperature and lose their dissolved material.

J. F. Kemp referred to the importance of the industry and the previous efforts that had been made near Syracuse to utilize the same materials. J. M. Clarke emphasized the possible part played by algæ in precipitating the calcium carbonate. The speaker replied that he had not found much evidence of them.

Glacial origin of the older Pleistocene in the Gay Head Cliffs, with a note on the fossil horse of that section. By J. B. Woodworth, Cambridge, Mass.

The occurrence of glaciated fragments in the boulder bed at the base of the older Pleistocene (Columbia) in the Gay Head Section was described and illustrated, confirming, it is thought, the theory of the existence of an ice invasion long antedating the surface moraines of the New England islands. The astragalus of a mammal identified with that of a horse, by Professor Osborn, was exhibited. This bone was found in the Miocene underlying the boulder bed at Gay Head.

Beach structure in Medina sandstone. By H. L. Fairchild, Rochester, N. Y.

The papers involved an exhibition, by lantern slides, of structural features in the Medina which indicate shallow water and beach deposits. The speaker referred to the phenomena described by G. K. Gilbert at a previous meeting as giant ripples, which suggested waves of 60 ft. height. Many views were shown illustrating them, and small ripple marks were seen on these crests. Individual cases without parallel neighbors were exhibited. The phenomena were then interpreted by the action of actual waves on the beach of Lake Ontario and they were explained as due to shore-wave action. C. W. Hayes cited similar phenomena on the San Juan River, Nicaragua, and H. S. Williams described channel fillings in the Devonian beds near Ithaca, which threw light on the cases in point.

Glacial erosion in the Aar Valley. By ALBERT PERRY BRIGHAM, Hamilton, N. Y.

Observations were made between Meiringen and the Abschwung. The valley has several relatively broad and open sections, containing small rock basins. These basins are filled with alluvial material. One double basin, however, that of the Grimsel Lakes, being out of the track of the stream, keeps its water-filling. Between the basins, in some cases, are narrow V-shaped gorges, bordered by heavily glaciated spurs thrown out from the valley sides. The sides of the gorges are often glaciated nearly to the bottom. In other cases rock barriers have crossed the valley and are now breached by very narrow post-glacial gorges, as above the Grimsel Hospice and above Meiringen. Supplementary illustrations were given from the Rhone and Visp Valleys.

W. M. Davis in discussion illustrated the discordance between side valleys and the main valley—the former discharging at an altitude of some hundreds of feet above the floor of the latter. These discordant, lateral valleys were called 'hanging valleys.' I. C. Russell remarked the same phenomena in the Sierras and Cascades. Bailey Willis emphasized the excess of lateral erosion by glaciers over the vertical and that thus the natural grade of the side valleys had been truncated. W. H. Niles laid stress on the importance of subglacial streams, along the sides of a glacier. G. K. Gilbert urged the efficiency of glacial erosion and stated that the profiles of lateral valleys did not coincide with the idea of truncation. The discordance may be met in rivers, as along the Rio Virgin, where the main stream deepens faster than the laterals. J. J. Stevenson corroborated the same views by the valley of the Twin Lakes in Colorado. J. W. Spenser described the hanging valleys of Norway, which are step-shaped at the discordance. I. C. White described discordance along the Monongahela Valley, where no glacier had ever existed. S. F. Emmons cited hanging valleys along the Columbia River, where it crosses the national boundary. H. W. Turner mentioned cases in the Sierras in the Bidwell Bar quadrangle. A. P. Brigham confirmed the power of a glacier to erode. W. M. Davis closed the discussion.

Movement of glaciers. By HARRY FIELDING REID, Baltimore, Md.

The paper gave the results of from one to three years' observations on the movement of the Forno glacier, with special reference to the vertical component of the movement. The existence of surfaces of finite shear in glaciers was discussed. The author described the set of stakes that he had set up at several places across the glacier and had watched for two or three years. They showed a slow movement at the end and a more rapid one up the ice-stream, and some interesting relations at the névé. He proceeded at once to the reading of his second paper.

Stratification and banded structure of glaciers. By HARRY FIELDING REID, Baltimore, Md.

Careful work on a number of the Swiss glaciers has enabled the author to follow the outcrops of the strata from the névé-line practically to the end of the glacier, and has convinced him that the banded structure is the modified appearance of the outcrops. A reason is suggested why glacialists have held divergent views on this subject. With a beautiful and complete series of lantern slides the author illustrated the evidences of stratification and the phenomena of movement. He distinguished stratification lines from the banding due to pinched crevasses and to other causes, and discussed the differences of Agassiz and Forbes regarding these phenomena. Bailey Willis commented on the close parallelism between ice movement and rock movement and inquired regarding the phenomena of movement. Dr. Reid replied that there was no shearing at all, but that plasticity sufficed to explain all the observed phenomena.

A channeled drumlin. By H. L. FAIRCHILD, Rochester, N. Y.

A few lantern views showed a longitudinal hollow (channel?) in a drumlin terminating at the lower end by a transverse cut.

The phenomena had puzzled the writer and after illustrating them he appealed to the Society in vain for an explanation.

Distinction between Upper and Lower Huronian. By A. P. COLEMAN, Toronto, Canada.

During the past summer a band of rock consisting of fine-grained sandstone, chert or jasper, with interbedded iron ore, has been found at Michipicoton, on the northeast shore of Lake Superior, corresponding to the Vermilion and other iron-bearing series west and south of Lake Superior. This band has been traced for 30 or 40 miles, and has been recognized at various points to the west as far as Rainy Lake and east to Lake Temagami. It is the most easily determined member of the Lower Huronian. Many fragments of this sandy, cherty or jaspery rock are found, as well-rounded pebbles in conglomerates of the Upper Huronian, at Gros Cap, a few miles west of Michipicoton, and at other points as far west as Shoal Lake and east as Lake Temiscaming, a distance of more than 600 miles. Jasper and other pebbles of these rocks furnish an easily applied test of the Upper Huronian, since their materials can have come only from the Lower Huronian. The basal conglomerates near Thessalon and also on Lake Temiscaming contain jasper pebbles, and hence indicate only the base of the Upper Huronian. This far-reaching break between the two parts of the series represents a great lapse of time, as proved by the Shoal Lake conglomerate.

In discussion C. D. Walcott disclaimed any conflict in the meaning of Algonkian and Huronian, making the former a much wider and more inclusive term than the latter.

The Cambrian formation in the Atlantic province. By CHARLES D. WALCOTT, Washington, D. C.

The work of Dr. G. F. Matthew and the use of the term Etcheminian series, by him, for a sedimentary series formerly considered to be pre-Cambrian and to be separated by a break from the Cambrian, was reviewed. The presence of a stratigraphic break between the Etchenimian and Cambrian was found not to exist. The apparent break is explicable by folds. The same relations were found in Newfoundland. Views were shown illustrating the Smith's Bay and Manuel's Brook localities.

The Lower Devonian aspect of the Lower Heidelberg and Oriskany formations. By CHARLES SCHUCHERT, Washington, D. C.

The Silurian of Murchison was compared with the American equivalents. The Devonian of Sedgwick and Murchison has no marked Lower Devonic fauna. The Lower Devonic of Germany was summarized. The Helderberg fauna is transitional to the Oriskany, and these two constitute the American Lower Devonic.

The paper was read by J. M. Clarke and the next three titles were taken up before discussion was begun.

The Silurian-Devonian boundary in North America. By HENRY S. WILLIAMS, New Haven, Conn.

The writer presented a discussion (*a*) of the principles to be used in determining the boundary between the two systems, Silurian and Devonian, the standard sections of which are on another continent, and (*b*) of the facts of correlation bearing upon the case.

He urged that to establish the top of the Silurian as the word was used by Murchison, we must find the equivalent of the Tilestone fauna. This has been done in the Arisaig fauna of the Maritime provinces, which is well developed in northern Maine and which lies over the Helderberg fauna at the same place. He therefore developed an argument for retaining the Helderberg in the Silurian.

The contact of the Silurian and Devonian in Erie Co., N. Y. By A. W. GRABAU, Troy, N. Y.

A limestone known as the Bullhead rock was found to contain fossils like those described by Whitfield from the Helderberg of Ohio. There is an unconformity between the Bullhead rock and the overlying Onondaga. A sandstone dike in a crevice in the limestone was described and some suggestions regarding the choice of a name for the Bullhead rock were made. The Manlius limestone was finally adopted, it having been used by Dr. J. M. Clarke.

Devonian strata in Colorado. By ARTHUR C. SPENCER, Washington, D. C.

The presence of Devonian rocks in southwestern Colorado, asserted by F. M. Endlich in 1874, has been confirmed by observation of the United States Geological Survey party under the direction of Dr. Whitman Cross.

The section when complete is threefold, consisting of a conglomerate and sandstone at the base, followed by a calcareous shale, and this by a massive limestone containing considerable numbers of invertebrate fossils. The limestone is shown by its outcrops to have covered an area of at least 600 square miles. The sandstone and shale beds are locally absent through non-deposition. Their age is possibly Silurian, though they contain occasional fish remains, which would ordinarily be considered indicative of the Devonian. The silicious series is correlated with the 'Parting Quartzite' of central Colorado, and mention is made of further probable equivalency between this series and the supposed Devonian of the Grand Canyon region. This brings out the probability that these formations of the Middle Paleozoic were originally deposited over a very extensive area in the southern Rocky Mountain region.

The fossils have been studied by Dr. George H. Girty, who considers that they are representative of a fauna older than that of the Chemung, and probably belonging at the base of the upper Devonian or near the top of the lower. Collections made by various geologists in central Colorado, are found to contain the same assemblage of fossils and to afford a basis for correlation. The fauna resembles that described by Whiteaves, from Hay River, Canada.

All four Devonian papers were discussed together. J. M. Clarke urged, regarding the delimitation of the Silurian, that it should rest upon the organic forms and their culmination, and not on the classification of Murchison. He then emphasized the Devonian aspects of the Helderberg of New York most strongly, and stated that its rich fauna should decide the question and with it the Arisaig would go. Dr. Clarke also corroborated the observations of Grabau by his own studies in the cement quarries of Buffalo.

H. S. Williams stated his method of solving the Devonian question as an endeavor to find in America an equivalent section to the classic section of the Old World. He therefore had searched for it in Maine and had discovered one above the Helderberg, which was almost exactly equivalent to the Tilestone. Other contrasts were instanced. C. H. Hitchcock remarked the importance of northern Maine as a place to decide this question, and mentioned Lake Telos as a promising locality. H. S. Williams again spoke, bringing up the Gaspé section and mentioning facts about northern Maine. J. M. Clarke also remarked his acquaintance with the Devonian fossils from Maine and reaffirmed the finality of the organic tests of correlation.

These papers concluded the session of Thursday. In the evening at 7.30 o'clock the Society assembled at the Hotel Raleigh for the annual banquet. To the delight of all present, Professor Emerson was found at the head of the table, and as usual a very merry evening followed. According to the admirable custom, now well established, the fellows brought their wives, and the ladies gave a brilliant aspect to the dinner. Ninety-five covers were laid, including about 15 for ladies.

J. F. KEMP.

COLUMBIA UNIVERSITY.

SCIENTIFIC BOOKS.

Frontinus and the Water Supply of the City of Rome. By CLEMENS HERSCHEL, Hydraulic Engineer. Boston, Dana Estes & Co. 1899. 4to. xlix + 296 pages.

Frontinus was appointed water commissioner of Rome in 97 A.D., and soon thereafter wrote his two books, generally called De Aquis, on its waterworks. The sole original Latin manuscript, dating from the twelfth or thirteenth century, is preserved in the library of a Benedictine monastery in Italy, and the photographic reproductions of its twenty-four pages which Mr. Herschel gives will be of interest to classical scholars. He also gives the Latin text and its English translation on facing pages, and adds twelve chapters of explanatory and critical matter which are of special value to civil engineers and archæologists; these are accompanied by eighty-four illustrations and three folding plates. This is the first time that De Aquis has appeared in English translation, and it is safe to say that no single volume has ever been published that contains such a wealth of information on the water supply of ancient Rome.

The treatise of Frontinus begins with a description of the nine aqueducts erected prior to 97 A.D., mentioning their builders, sources and lengths. The subject of water measurement is next discussed and the sizes of the standard pipes are given, this being preparatory to determining the amount of water furnished by each aqueduct and how much was used for fountains, for public buildings and for private uses. Then the quality of the waters and the laws for the prevention of pollution receive attention, and this is followed by a statement of the duties and powers of the water commissioners, and of the regulations for preventing the unlawful use of water. Lastly, the methods of repairing the aqueducts are discussed, and the laws for ensuring their proper maintenance are given.

Mr. Herschel discusses at length the engineering and hydraulic features of the aqueducts and of the methods of distributing the water. It is clearly shown that the Roman engineers had no rational methods of measuring water, such quantities as cubic feet per second or gallons per hour being beyond their powers of conception. The unit of measurement used by them was called a 'quinaria,' this being originally a circular pipe whose diameter was $1\frac{1}{4}$ Roman digits, later the number of square units in the cross-section of this circle, and later the quantity of water passing through this area. Evidently it was understood that the discharge through a pipe or channel would vary with the velocity, as Frontinus says that the aqueduct Virgo could not be properly measured near its source, where the current was too slow, but near the city where the velocity was greater he found it to give 2504 quinarias. In general, however, the measurement of water was made by finding the area, in quinarias, of the cross-section of the channel or pipe; thus a denaria pipe, whose diameter was double that of the quinaria pipe, was supposed to discharge four quinarias of water.

The statement is commonly made in cyclopædias that the aqueducts of ancient Rome delivered about 300 gallons of water per day for each inhabitant, a consumption about three times as great as that of American cities. This statement is traced by Mr. Herschel to certain hypothetical computations published by Prony in 1817, which are shown to rest upon unwarranted assumptions. A probable value of the quinaria is found in three different ways: first, by computations from the measured cross-section of an aqueduct now standing and the ancient slope of its water surface as marked by the incrustations of the deposited limestone; second, by actual gaugings of those ancient aqueducts that are now in use; and third, by computations from reasonable data of the discharge of pipes which delivered water to houses. An analysis of the work of Blumenstihl and Belgrand leads to the conclusion that the value of the quinaria was somewhere between 2500 and 9000 gallons per day. Accepting the statement of Frontinus that 14,000 quinarias were delivered within the city, and calling its population one million, it follows that the consumption was between 35 and 126 gallons per person per day, and when it is considered that one or more of the aqueducts were generally out of service owing to the progress of repairs, the lower figure is probably nearer to the actual consumption. Mr. Herschel's final conclusion is that the probable daily consumption was 38 gallons per person, although the actual value doubtless varied some 20 gallons on either side of that figure.

The Roman laws regarding the injury of aqueducts, the pollution of their waters, and the unlawful use of water have formed the basis of modern statute law for the protection of public water supplies. Regarding the distribution of water to buildings, it is interesting to note that direct connections with the aqueducts and street mains were forbidden; these mains delivered the water to small distributing tanks, and a house connection was made to one of these tanks by a quinaria pipe. It was required by law that this pipe could not be increased in diameter within a distance of fifty feet from the tank, since by so doing the discharge would be increased. These water tanks were under the charge of men called 'aquarii,' who probably bought the water from the city and sold it to consumers, since various methods devised by them to defraud both the city and the consumers are described and severely denounced by Frontinus.

Roman arithmetic and mensuration form the subject of one of Mr. Herschel's interesting chapters, but his statement that Frontinus used for π the value $3\frac{1}{7}$ seems to be scarcely warranted. In fact the list of fractions used by Frontinus does not contain $\frac{1}{7}$, that list being $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{12}$, $\frac{1}{24}$, $\frac{1}{36}$, $\frac{1}{48}$, $\frac{1}{72}$, $\frac{1}{288}$, and multiples of these. From the diameters and circumferences of several pipes, as stated in De Aquis, the writer concludes that the value of π used in computing the latter from the former was probably $3\frac{41}{288}$, or, in the notation of Frontinus, $3 + \frac{1}{12} + \frac{1}{24} + \frac{1}{72} + \frac{1}{288}$.

Mr. Herschel remarks that Frontinus takes high rank, even to-day, as a practical superintendent of waterworks. His first care on assuming the office was to ascertain the history of the aqueducts and the regulations and customs regarding the measurement of the water; then he made gaugings to ascertain the amount of water carried by the aqueducts and the consumption. Finding the latter far less than the former, he traced the discrepancy to unlawful connections. The laws relating to these were then enforced and measures taken to prevent waste. The result was that "the cleanliness of the city is greatly improved, the air is purer, and the causes of pestilence are removed"; at the same time "those who with fear drew water unlawfully, draw their supply now free from care, by grant from the sovereign," and thus morality was promoted.

It is a matter of congratulation that the first English translation of Frontinus' De Aquis should have been made by a hydraulic engineer highly qualified to interpret it. In fact our knowledge of Frontinus and his work is mostly due, not to classical scholars, but to technical men, the French and German translations having been made by the civil engineers Rondelet and Dederich. The writer of a history of Rome, published at Boston in 1886, refers to the book of Frontinus as belonging "to the class which furnish facts without giving ideas." If, however, Frontinus be read carefully by those who are able to understand the facts, as scientists and civil engineers can do, it appears, as the

English translator well says, that many and valuable ideas may be obtained. The interesting commentaries contained in this volume render it possible for even the general reader to do this with pleasure and profit.

MANSFIELD MERRIMAN.

Gleanings from Nature. By W. S. BLATCHLEY. Indianapolis. 1899. 16mo. 348 pp., 15 pl., 100 cuts.

The State Geologist of Indiana has here given us a dozen or more chapters on the natural history of his State, with the laudable purpose of interesting young people in the objects about them. If but a fraction only of the 800,000 children to whom he dedicates the book will read it, the results should be good; for the author speaks at first hand of all he writes, and seems equally at home whether discoursing of quadrupeds, birds, reptiles, fishes, insects, trees, weeds or caverns, to which latter feature of southern Indiana much space is given. We have noticed but one serious error, where the femora of *Mantis* are taken for tibiæ. The stories are simply told, and derive their chief value from being the outcome of close personal contact with nature and from their local flavor. The book is to be heartily recommended to the young people not only of Indiana but of the neighboring states, to which it is nearly as well adapted. It will take them out of doors on every page and awaken a new interest in living nature. The illustrations are mostly good, many excellent and all to the purpose. There is a sufficient index.

S. H. S.

LIVERPOOL MARINE BIOLOGICAL COMMITTEE'S MEMOIRS.

THE appearance of No. I., of the Liverpool Marine Biological Committee's 'Memoirs on Types of British Marine Plants and Animals,' deserves more attention from teachers and students of natural history than the intrinsic scientific value of the volume, however much this may be, can justly claim. This because of the uniqueness in several ways of the series which this number introduces. In the first place these volumes are to be unique in the matter of price. Who has ever before heard of a bound volume, in the English tongue at least, on a natural history subject, written by a distinguished specialist, and containing fifty pages and four good plates, being sold for 37½ cents? Yet that is the price of this first memoir.

It is written by the editor of the series, Professor W. A. Herdman, and the type treated is *Ascidia*, as might be anticipated from the editor's long and distinguished devotion to the group of animals of which this is a representative.

The series again is well-nigh unique in its origin and purpose. What these are may be best shown by extracting a paragraph from the editor's preface.

"In our twelve years, experience of a Biological Station (five years at Puffin Island and seven at Port Erin), where college students and young amateurs formed a large proportion of the workers, the want has been constantly felt of a series of detailed descriptions of the structure of certain common typical animals and plants, chosen as representatives of their groups, and dealt with by specialists. The same want has probably been felt in other similar institutions and college laboratories."

Some twenty other memoirs of like nature and by nearly an equal number of workers are promised.

It is hardly necessary to say that the number before us is scientifically accurate and up to date. It could hardly be otherwise; for its author has himself contributed more than any one else to the making of our knowledge what it is to-day, of the structure and speciography of the Tunicata. No one is better able than he to write such a book, and he has written it as well as he is able to.

The only instances in which I have noticed any doubtfulness or unclearness of statement are in connection with the pericardium and heart, and the coelom. On page 34 we are told that the "pericardial sac and its invagination the heart have formed in the mesoblast between the endostyle and stomach." A reader not already familiar with ascidian embryology would find difficulty, I should think, in harmonizing this statement with the clear statement of the fact found on page 10, viz.: that the "pericardium [from which the heart itself is produced] and epicardium originate as outgrowths from the archenteron." Comparing the two statements such a reader *might* conclude that the first statement quoted means that the pericardial sac and its invagination are *embedded in* mesoblast as their formation proceeds, but he would also be justified in understanding the one statement to mean that the pericardial sac and hence the heart are of mesoblastic origin, while the other means that they are of hypoblastic origin.

Again the statement (page 10) that the cavity of the pericardium and epicardium 'may be regarded as coelomic spaces' is not exactly clear when compared with the statement made a few lines below on the same page, that the cavities of the renal vesicles and gonads are sometimes interpreted as being formed 'by a splitting of the mesoblast (*coelomic*).'

But the book is an admirable résumé of our knowledge of a typical ascidian, and if the succeeding numbers are equally satisfactory, the series cannot fail to be a potent factor in promoting the study of natural history not only in Great Britian, but as well beyond its borders.

It is unfortunate that the volumes could not be bound a little more securely, for they will hardly withstand the rough usage which they are pretty sure to receive as laboratory guides. If this could not be done without increasing the price, and if the price could not be increased even by a small amount, then it seems to me that it would be better to cut down the text and illustrations, particularly the former, somewhat, and apply the saving in expense thereby to making the binding better.

WM. E. RITTER.

GENERAL.

A LIMITED number of the reports of the University Geological Survey of Kansas still remain for distribution among persons who are interested in mining and geology. The publications to date include five volumes bound in cloth, and two annual reports on the Mineral Resources of Kansas bound in paper. All these may be had for the asking, except Vol. I., the supply of which is entirely exhausted. Persons writing for any or all of the reports should enclose the necessary postage, or request that they be sent by express. The volumes are: Vol. II., General Geology of Western Kansas, postage 26 cents; Vol. III., a Special Report on Coal, postage 28 cents; Vol. IV., Paleontology of the Upper Cretaceous, postage 32 cents; Vol. V., A Special Report on Gypsum and Gypsum Cement Plasters, postage 16 cents; Annual Report of Mineral Resources of Kansas for 1897, postage 4 cents; Annual Report on the Mineral Resources of Kansas for 1898, postage 7 cents.

MESSRS. D. APPLETON & COMPANY have nearly ready for publication *The International Geography*. Seventy authors have collaborated in its production, including the leading geographers and travelers of Europe and America. The work has been planned and edited by Dr. H. R. Mill, who also wrote the chapter on the United Kingdom. Among the authors are Professor W. M. Davis (The United States), Dr. Fridtjof Nansen (Arctic Regions), Professor A. Kirchhoff (German Empire), Mr. F. C. Selous (Rhodesia), Professors de Lapparent and Raveneau (France), Sir Clements Markham, F. R. S. (Ecuador, Bolivia, and Peru), Sir John Murray, F. R. S. (Antarctic Regions), Count Pfeil (German Colonies), Mr. James Bryce, M. P. (The Boer Republics), Sir H. H. Johnston, the late Sir Lambert Playfair, Sir F. J. Goldsmid, Sir Martin Conway, Sir George S. Robertson, Sir William MacGregor, Sir Charles Wilson, F. R. S., the Hon. D. W. Carnegie, Mrs. Bishop, Dr. A. M. W. Downing, F. R. S., Dr. J. Scott Keltie, and Mr. G. G. Chisholm. The book is illustrated by nearly five hundred maps and diagrams which have been specially prepared.

OTHER books announced for early publication by Messrs. D. Appleton & Co. include Comparative Physiology and Morphology of Animals, by Professor Joseph Le Conte; Some Great Astronomers, by Dr. Edward S. Holden, and the Story of Eclipses, by Mr. G. F. Chambers.

SCIENTIFIC JOURNALS AND ARTICLES.

WITH the December number the *American Naturalist* completes its twenty-third volume. Hermon C. Bumpus has the leading article, on

'Facts and Theories of Telegony,' which gives a brief review of the subject in general and of the recent experiments by Professor Ewart in particular. Edward Thorndike in a 'Note on the Psychology of Fishes' tells of a simple experiment by which it was shown that the common Fundulus could readily learn the proper route of escape from the compartment of an aquarium in which it was confined. C. E. Mead discusses '*Collops bipunctatus* as an Enemy of the Colorado Potato Beetle,' concluding that it is an important agent in protecting the potato crop. 'The Egg-Carrying Habit of Zaitha' is described by Florence W. Slater, and Robert T. Edes treats of the 'Relation of the Chirping of the True Cricket (*Oecanthus niveus*) to Temperature,' showing that the rapidity of the chirps increases with the temperature. 'Regeneration in the *Hydromedusa*, *Gonionemus vertens*' is discussed in detail by T. H. Morgan, whose experiments show that, although pieces smaller than one-eighth of the medusa may make new individuals having the medusa form, the remodeling does not include the internal organs. Richard C. McGregor has an article on '*Salvinia coccinea*, an Ornithophilus Plant,' describing the manner in which pollination is effected by humming birds, and the sixth instalment of 'Synopses of North American Invertebrates,' by W. P. Hay, is devoted to the *Astacidæ*. The reviews are numerous, and under Correspondence Henry B. Ward puts in a plea for the use of Mesenchyme.

The *Journal of the Boston Society of Medical Sciences* for December has for its first article an abstract of a paper by Charles S. Minot on the 'Classification of Tissues,' which takes the ground that this should be based on embryological data. W. F. Whitney describes some 'Malformations of the Kidneys,' and Thomas Dwight some 'Remarkable Skulls.' The final article 'Experiments on *Saphrolegnia ferax*, and their Application to the Trout Hatchery,' by J. H. Cunningham, Jr., is of much interest to fish culturists.

The Osprey for December opens with some 'Notes from Northern Counties of California,' illustrated by Milton S. Ray; this is followed by a reprint of J. E. Harting's article on 'The Largest Bird that Flies,' which is the subject of some interesting editorial comment. There is a brief biographical sketch, with portrait, of the late D. W. Prentiss. The editorial columns contain a description of the recent meeting of the American Ornithologists' Union, and among the letters is the prospectus of the Third International Ornithological Congress, to be held in Paris during the coming year, and a record of the bird arrivals at Dawson.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES. SECTION OF GEOLOGY AND MINERALOGY.

At a meeting of the section on December 18, 1899, in the absence of the Chairman, Professor J. J. Stevenson was elected temporary chairman. Twenty-six persons were present.

Professor J. F. Kemp presented a paper on 'Recent Theories Regarding the Cause of Glacial Climate.' During the subsequent discussion of this paper by Professors R. E. Dodge, D. S. Martin and others, Professor Stevenson called attention to the fact that the great excess in the area of the peat bogs on the surface of the earth, during the present period, over that of the swamps which prevailed during the Carboniferous, shows the little foundation for the hypothesis of an excess of carbon dioxide in the atmosphere during the formation of the coal. Dr. Julien also pointed out, in reference to the theory of the refrigerating influence of the absorption of carbon dioxide from the atmosphere, during the decay of rocks, that this effect may have been more than offset by the heat produced during the accompanying absorption of oxygen.

Professor Kemp then read a paper on 'Metamorphosed Dikes in the Mica Schists of Morningside Heights.' This paper was discussed by several members. Dr. Julien acknowledged the resemblance of this outcrop of black hornblende schist to a sheared dike, produced by its strong contrast in color with the enclosing light gray micaceous gneiss, and by the sharp lines of separation of the schist from the highly tilted beds on either side, as if thrust up from below. Yet this is but one of hundreds of exactly similar outcrops in New York and Westchester

Counties. All are intercalated, however, as thin beds in the Manhattan Series; in not a single case has a hornblende schist been observed to cross the other beds. If one or all of these are dikes, the lamination of the associated beds must also have been effected by a general shearing. But the series is accepted as typically metamorphic, a succession of true beds of altered sandstone (quartzitic gneiss), shales (mica schist), magnesian schists (dolomite marble), etc., into which the injection of trap dikes exclusively between the beds would be entirely improbable. These hornblende schists, moreover, on Morningside Heights, as elsewhere, thin out along the strike like the other lenticular beds, often become partially or entirely biotitic and quartzose, passing gradually into biotitic schists, biotitic and hornblende gneisses, exactly like those of acidic constitution which enclose the above supposed dike. Indeed, a basic element, rich in lime and magnesia, is distributed throughout the Manhattan Series, and was originally perhaps hornblendic throughout, or, in the absence of silica, concentrated in the numerous dolomite beds. The more purely hornblendic layers correspond in composition, as shown by the interesting analysis in the author's paper, to beds of altered marl; their density has enabled them to resist and escape, in the present surviving layers, the biotitic alteration which has affected the general series.

A paper was then presented with lantern illustrations by Mr. W. D. Matthew, 'Notes on the Geology of the Laramie Plains and Rattlesnake Mountains in Wyoming.' Professor H. F. Osborn remarked on the uncertainty of the age of the *dinosaur*-beds, whether Jurassic or Lower Cretaceous. All determinations hitherto have been made by collectors, but neglected by the paleontologists, though the section is here continuous from the Mountain Limestone of the Carboniferous up to the base of the Cretaceous. Nor has the correlation yet been made with the corresponding beds of the Wealden, Purbeck, etc., of England and the European Continent. The æolian theory of the author, however, does not appear consistent with reported observations of remains of aquatic life in these beds. The Chairman stated that no true Mountain Limestone fossils have yet been detected in the bed so called in Wyoming, nor the good evidences yet needed of Jurassic life in the *dinosaur*-beds, of other vertebrate life, lacustrine remains, etc., of that age, and for confirmation of synchronism of Jurassic life between the continents. As to the heavy oils of Wyoming, they contain but little paraffin and perhaps less than twenty per cent. of kerosene, and are likely to be worthless, except possibly hereafter for use as a coarse fuel. The paper was further discussed by Professors Dodge, D. Van Ingen and others.

ALEXIS A. JULIEN,
Secretary of Section.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 297th regular meeting of the Society was held Tuesday evening, December 19, 1899.

Mrs. M. C. Stevenson read a paper on 'Zuni Games,' in which several ceremonial games were technically described, and the errors of other observers and writers pointed out. The author claimed that these errors were due to a superficial acquaintance, not only of the game itself, but to the lack of familiarity with the people and their language. It was necessary to live a long time with them in order to discover the true meaning of many of the details.

Dr. J. H. McCormick read a paper entitled 'The Supernatural in Primitive Concept,' in which he traced the origin and development of primitive ideas of religion and pointed out the four universal primitive doctrines of Physianthropy, Animism, Transmigration and Anthropomorphism, and the influence exercised by each upon such concepts.

Mr. George R. Stetson gave 'Some Curiosities of Philological Literature.'

Mr. Stetson examined the literature of Comparative Philology from the point of view of the student "who is disturbed if not somewhat appalled by the prevailing confusion and contradictions in the understanding and application of the technical terms used by philologers."

In behalf of the inquirer whose mental vision is obscured by the divergent concepts and theories advanced by the various professional writers in regard to the origin of speech, and the genesis, formation, growth and classification of language, Mr. Stetson appealed to the latter to exercise greater care in announcing, and greater diligence in seeking for unanimity in their concepts.

He suggested that, in order to prevent the existing confusion among professional writers as well as among students, it was imperative that a line be drawn and a classification adopted which shall definitively separate the crude, fluctuating, undeveloped, and unrefined speech of a narrowly circumscribed region—*i. e.*, the 'dialectic stage'—from the comparatively fixed and highly developed inflected speech of an extensive area, or the 'cultivated stage.'

That patois and dialect should cease to be used as synchronal or equivalent terms, as in the history of language the former represents the destructive and the latter the constructive period.

That the use of 'dialect' as a relative term, by which the meaning of the 'dialect' and 'language' is made to depend upon the connection in which the terms are used should be abandoned, in the interest of clear thought and intelligible classification.

That writers should more particularly differentiate 'speech' from 'language,' and, in comparative philology, the study of the affinities of language, from linguistics, the study of the derivation of words.

That the classification and relations of dialect, language, patois, and jargon be more absolutely defined and rescued from their present confusion by some authoritative body.

That the aim of writers on comparative philology and experts in linguistics should be to more completely separate the conceptual and hypothetical from the practical and profitable, and thus prevent the needless waste of thought and effort.

"That more is to be learned from analogy and living speech, as Professor Sayce suggests, than from dead literature," or it may be added from the questions of origin and precedence.

In conclusion Mr. Stetson remarked that he did not wish to convey the impression that the absence of unanimity in concepts and confusion in terminology is peculiar to the writers on philology; he feared that they might be found in a greater or less degree in all philosophical inquiries.

He also expressed the opinion that students generally, in view of the prevailing contradictions, the dearth of recorded facts, and superabundance of hypotheses, are not inclined to accept without question the present claim of comparative philology as a science, and that while extremely valuable work has been and is being done,—especially in the division of linguistics, a study which has been practically born within our memory,—its essays and instruction are too frequently founded upon hypotheses "which furnish no perceptible evidence of truth or of value in their practical application."

J. H. McCormick,
Secretary.

DISCUSSION AND CORRESPONDENCE.

HOMOLOGIES OF THE WING VEINS OF HYMENOPTERA.

Very important investigations of the morphology of the venation of the wings of insects have recently been made by Professor Comstock in his 'Manual for the Study of Insects,' published in 1895, and more recently by Comstock and Needham, in a series of articles published in the *American Naturalist*, 1898–99, reissued as a pamphlet of 124 pages and 90 figures by the Comstock Publishing Company.

While I accept their principles, the application of them and a comparison of the figures lead me to a different conclusion with regard to homologies of the wing-veins of hymenoptera, which in connection with my studies of the bees it has been very important for me to work out. In the Manual vein M is regarded as three-branched, as in the diptera, but in the later articles this vein is regarded as four-branched.

In the first place I regard the wing of *Macroxyela* (Manual, p. 606, fig. 705) as a better example of the typical hymenopterous wing than the composite wing produced by a combination of the wing of *Macroxyela* and *Pamphilius* (*Am. Nat.*, 414; figs. 38–39). But the latter will illustrate my views.

My conclusions are: that the cross-vein m connects M_2 and $M_3 + Cu_1$, as in the wing of

Pantarbes (40) and *Rhamphomyia* (41), and that the cross-vein marked *m — cu* in *Leptis* (*Am. Nat.*, 32; 337, fig. 30) does not exist in the hymenoptera, but is obliterated by the coalescence of the above-mentioned veins; M_4 is Cu_1, and Cu_1 is Cu_2; the cross-vein marked *m — cu* is not homologous with the one so marked in *Leptis*, but belongs to the *arculus!* To account for the vein marked Cu_2 I should say that it is before the arculus and does not enter in the consideration of the ordinary cases. According to the authors, this vein does not occur in any of the hymenoptera, except *Pamphilius*.

If my view is correct, a large part of the peculiarities of the venation of hymenoptera is connected with the great lengthening of the arculus and the shifting of it from the base of the wing.

The only changes in the designation of the cells which my attempt at elucidation involves are: M_3 is Cu_1; Cu_1 is *2nd Cu; Cu* is *1st Cu; M* is homologous with the cell marked *1st M* in *Scenopinus* (*Am. Nat.*, 32; 339, fig. 36); M_4 is the same as the cell marked *2nd M* in *Scenopinus* and the cell marked *M* in *Rhamphomyia* (41).

CHARLES ROBERTSON.

NOTES ON INORGANIC CHEMISTRY.

A GOOD illustration of how much material there is in inorganic chemistry which needs reinvestigation, is found in the fact that there has been no general method of forming the sulfids of the rare earths, nor have any of the sulfids been obtained in a pure condition, with the possible exception of that of cerium. This gap has now been filled by Muthmann, of Munich, in conjunction with L. Stützel. They find that while the oxids are very slowly converted into sulfids when heated in a stream of hydrogen sulfid, the anhydrous sulfates are, under the same conditions, very readily converted quantitatively into the sulfids. The sulfids of cerium, lanthanum, neodymium and praseodymium were formed in this way, and their properties, physical and chemical, studied. They are fairly stable in the air at ordinary temperature, but are decomposed with evolution of hydrogen sulfid by warm water or dilute acids. They take fire readily on heating in the air, and when finely divided the cerium sulfid often proved pyrophoric. They burn to a mixture of oxid and sulfate. On heating in a current of dry hydrochloric acid, they are readily and quantitatively converted into the anhydrous chlorids, and on a small scale this is the best and easiest method of preparation of these chlorids. The study as a whole, which is published in the last *Berichte*, is a valuable contribution to the chemistry of the rare earths.

IN a series of experiments by A. Petterson, of Upsala, printed in the *Klinische Wochenschrift* (Berlin), the fact is established that in meat and fish preparations, containing 15% of salt for the purpose of preservation, a constant and luxuriant growth of microörganisms takes place. From this the conclusion is drawn that the special flavors, odors, consistencies, and colors of salt conserves are chiefly produced by various microörganisms.

THE subject of food preservatives is also discussed from a different standpoint by R. Kayser, of Nuremberg, in the *Zeitschrift für öffentliche Chemie*. In earlier times, the tendency of various foods to decomposition was counteracted by drying, smoking, pickling and the like. In some cases special processes were used, as the treating wine with sulfur, beer with hops, etc. At the present day, scientific progress has led to the use of low temperatures, of sterilization, and especially to the use of chemicals. In this last case the demand is made that the preservatives used shall not only be harmless in the quantities used, but inert to the human system even in vastly greater quantities than ever used in foods. This demand, it is pointed out, is unprecedented, for it is not complied with under old methods. Common salt, saltpeter and creosote are present in these and are not less injurious in quantity than the more recently used boric acid, borax, salicylic acid, benzoic acid, etc. There are no authentic instances on record of injury from the use of any of these in foods, while there are very many instances of injury from foods which, apparently good, were in reality decomposed (presence of ptomains, etc.). The whole subject needs to be treated in a more rational way.

The latest numbers of the *Chemical News* contain reprints of several papers on the new radiant substances discovered by M. and Mme. Curie. It is found that the radio-activity of polonium and radium can be communicated by contact to inactive bodies, such as many metals, paper, barium carbonate and bismuth sulfid, and this induced radio-activity persists for a considerable time.

Mme. Curie has concentrated by fractionation the radium which is associated with barium in the uranium minerals, and determined the atomic weights of the successive fractions—one fraction having an activity 3000 times that of uranium had an atomic weight of 140. (Ba = 137.8.) A later fraction of 7500 times uranium's activity had an atomic weight of 145.8, hence it seems that radium has a higher atomic weight than barium. In this work half a ton of uranium mineral was used and the radiferous barium chlorid which was fractionated amounted to two kilos. The spectrum of this concentrated radium was studied by Demarçay, and in addition to the spectrum of barium, very intense and complete, a series of new lines was found and measured. Some of these are very characteristic. It thus appears reasonably certain that radium has a definite position as a chemical element, and the properties of the purified substance will attract great interest when determined. Among the chemical effects of the salts of radium is the conversion of oxygen into ozone. This phenomenon seems to be connected rather with the radio-activity than with luminosity. Radium carbonate is very luminous, but produces less ozone than radium chlorid, which is much less luminous, but more strongly radio-active. If a radium salt is placed in a glass vessel, a violet coloration is seen in the glass which proceeds from the interior to the exterior. In ten days or so the bottom of the flask is almost black. This takes place in glass containing no lead. The effect of the Bacquerel rays upon barium platino-cyanid is also chemical. All these phenomena point to the fact that the rays emitted by radium present a continual development of energy.

J. L. H.

CURRENT NOTES ON METEOROLOGY.

THE WEST INDIAN HURRICANE OF AUGUST, 1899.

An account of the West Indian hurricane of August 7–17 last, in the *Monthly Weather Review* for August (issued October 30), brings out several points worth noting here. The report from the Weather Bureau observer at Arroya, Puerto Rico, says that the Spanish steamship *Alava* took refuge in the Port of Jobos, and with all her anchors down and working full speed ahead, she dragged for half a mile. At Aguadilla, Puerto Rico, the passage of the calm central 'eye' of the storm occupied about one hour. At Nassau, considerable damage was done by the northeast wind, which backed to northwest, and fell calm. People then came out to gather up their scattered effects, when the wind suddenly began to blow from the southwest with great force. An aneroid reading of 27.75 inches, corrected for instrumental error and for elevation, was made at Guayama, Puerto Rico, and one of 28.11 inches was made at Juana Diaz.

RECENT PUBLICATIONS.

Note.—The unusually large number of recent publications of importance makes it necessary, in view of the limited space, to restrict our mention of them to a few lines only.

Evelyn B. Baldwin: 'The Meteorological Observations of the Second Wellman Expedition,' *National Geographic Magazine*, December, 1899, 312–316. Mr. Baldwin is an official of the United States Weather Bureau, and was equipped with instruments by the Bureau. This is a preliminary report of his meteorological work.

Frank H. Bigelow: 'The probable State of the Sky along the Path of Total Eclipse of the Sun, May 28, 1900, Observations of 1899,' U. S. Department of Agriculture, Weather Bureau. Bulletin No. 27. 8vo. Washington, D. C., 1899. Pp. 23. Charts IV. This report summarizes, for the information of astronomers and others interested in the approaching eclipse, the results of observations made in 1897, 1898 and 1899 to determine the prevailing average cloudiness in the districts covered by the eclipse track.

Frank H. Bigelow: 'Some of the Results

of the International Cloud Work for the United States,' *American Journal of Science*, December, 1899, 433–444. A preliminary statement of results which are soon to be published *in extenso* by the Weather Bureau.

OLIVER L. FASSIG: 'Types of March Weather in the United States,' *American Journal of Science*, November, 1899, 319–340. A discussion of the relations existing between the mean atmospheric pressure, the prevailing character of the weather and the paths of storms.

WILLIS L. MOORE: 'Report of the Chief of the Weather Bureau for 1899,' U. S. Department of Agriculture, Weather Bureau. 8vo. Washington, D. C., 1899. Pp. 23.

B. S. PAGUE: 'The Mild Temperature of the Pacific Northwest, and the Influence of the Kuro Siwo.' 8vo. Portland, Ore., 1899. Pp. 11. Charts III. The author classifies the temperature conditions of the north Pacific Coast into continental, dynamic and oceanic types. He believes that dynamic heating of descending air is more effective than the influence of the ocean in producing the mild winter temperatures of the Pacific Northwest.

R. DEC. WARD.

HARVARD UNIVERSITY.

RECENT ZOOPALEONTOLOGY.

Adaptive radiation of the Camels and Llamas.—Professor Scott advances the following hypothesis in his recent important memoir:

"The most interesting and striking result to which the study of the Uinta selenodonts has led is the very unexpected conclusion that, with the possible exception of the *oreodonts* and *agriochoerids*, all of the strictly indigenous North American *selenodonts* are derivatives of the tylopodan stem. Paradoxical as this conclusion may appear, I believe it to be fully justified by the evidence which will be laid before the reader. The Tylopoda are thus seen to be a very ancient and highly diversified group, comparable in this respect to the Pecora, or true ruminants, which they so closely resemble in many features. The Pecora are an Old World group, which underwent great expansion and diversifications in Eurasia, but did not reach this continent till late Miocene times, and never attained the importance here that they have so long had in the Eastern Hemisphere. Their place was, to a very great extent, taken in America by the Tylopoda, which ran a course of development in many ways parallel to that of the Pecora and Tragulina, but with a variety and diversity of structure, habit, and appearance, such as are not attained in either of the latter groups." It has long been known that the Camels and Llamas had their home on this Continent, but Professor Scott's hypothesis, that practically all the American Artiodactyls, except the pigs, sprang from a common cameloid stem, is of the greatest interest. If confirmed, it will take rank as a brilliant generalization resulting from recent exploration. Even if not confirmed, it will be of great value as stimulating closer inquiry into the natural relationships of the American even-toed Ungulates. *Trans. Wagner Free Institute*, Phila., May, 1899, Vol. VI.

The Pliocene Hyrax.—*Pliohyrax* Osborn is identical with *Leptodon* Gaudry. This rather dry announcement relates to an interesting extension of our knowledge of the Hyracoidea. For some years a skull found upon the Island of Samos awaited description in the Stuttgart Museum; Professor Fraas kindly placed it in the hands of Professor Osborn, who described it before the International Zoological Congress, at Cambridge, as a new and very remarkable form of *Hyrax* from the Lower Pliocene, as the only fossil representative of this order and as belonging to a distinct family of Pliohyracidae and a distinct genus *Pliohyrax krupii*. It now appears that the lower jaw found by Professor Gaudry in Pikermi, Greece, and long known as *Leptodon graecus* belongs to the same type as the above. Dr. Max Schlosser, of Munich, points this out in an interesting article in the *Zoologischen Anzeiger* of October. He leaves the animal among the Hyracoids and suggests that it is of South American origin, a suggestion of considerable probability and of very great interest.

Exploration for Dinosaurs.—Great activity prevailed last season in the search for the remains of Dinosaurs. A report of the parties exploring in the Dinosaur beds under the direction of Professor W. C. Knight has already been made in this JOURNAL. In addition to the scattered fossils thus secured by representatives of many institutions, there were five fixed parties in the field. The three representing the Field Columbian Museum, the University of Wyoming, and the University of Kansas had their quarries in the Freeze Out Mountains. A few miles to the east was the Carnegie Museum party under the direction of Dr. Wortman; they found a very promising locality in which a large portion of a skeleton of Diplodocus was secured. To the southeast was the American Museum party, which continued the excavation of the 'Bone Cabin Quarry' with good results, and four miles west of this point secured a considerable part of a Brontosaur skeleton. In the quarry itself the greater portion of a Mososaur skeleton was found in a very much crushed condition. Altogether the general work of the season will greatly advance our knowledge of the Dinosaurs. At the same time the beds in the Como region have been so thoroughly explored that it is becoming very difficult to find these animals, and when found it is very difficult to take them out.

Ear bones of Marsupials.—According to Richard Weil,* the ossicula auditus of the opossum are not at all parallel in their development with those of the pig, considered as a representative of the Placental mammals. This tends further to confirm the conclusion, arrived at from many other grounds, that Marsupials are entirely to be regarded as forms parallel to the Placentals rather than as ancestral forms. As regards the origin of the malleus, Weil's investigation confirms the prevailing opinion that it is derived from Meckel's cartilage or the mandibular arch. The incus also arises from the mandibular arch and has no relation to the hyoidean arch. Mr. Weil believes that Kingsley has placed too much dependence upon the relation of the nerves to these elements. Weil's results directly contradict the theory of Reichert, Huxley and others, that the quadrate of the Sauropsida is represented in the auditory chain of Mammals, for according to his observations the quadrate belongs not to the mandibular arch from which the Mammals derive their ear bones but to the palatoquadrate bar.

* *Annals N. Y. Acad. Sci.*, Vol. XII., No. 5. Pp. 103 to 118, July 7, 1899. 'Development of the ossicula auditus in the opossum.'

The Fins of Ichthyosaurus.—Professor Fraas, of Stuttgart, describes the most perfect specimen of an Ichthyosaur which has yet been found in the famous quarry in Holzmaden. It exhibits in a remarkable manner the structure of the fins, having been worked out with the utmost care by Herr Bernhard Hauff for the Royal Geological Museum of Hungary. Although partly described by Owen, the complete dermal structures of Ichthyosaurs were first discovered in the Holzmaden quarry in 1892. Five specimens have been found altogether in a somewhat restricted part of the quarry. The skin impressions are of a light brown to a deep black color with a grayish slate blackground, and are so fine that they must be exposed with the greatest skill by the use of a fine scapel working under a magnifying lens. The specimen here described gives a perfect picture of the dorsal and caudal fins and of the fin folds surrounding the paddles. The irregular folds behind the dorsal fin represent a displacement of a portion of the pigmented skin from the sides of the body. The caudal fin is remarkable in the elongation of its upper lobe, but it is not at all evident how this lobe was supported, since, unlike the sharks, the tail vertebræ turn down into the lower lobe.

H. F. O.

*AGRICULTURAL EXPERIMENT STATIONS.**

THE most obvious indication of the success of experiment stations as a means for improving agricultural conditions in this country is the steady increase in the number of stations and station officers, and in the amount of financial support which they have received from the National and State governments. In the first volume of the *Record* it is stated that in 1889 there were 46 stations in the United States, receiving an aggregate revenue of about $725,000, of which $600,000 was appropriated from the National Treasury and $125,000 was received from State governments and other local sources. The total number of persons engaged in the work of the stations and at this office that year was 402. In 1898, the last year for which statistics have been compiled, the total number

* From *Experimental Station Record.*

of stations was 54. Their total income was somewhat over $1,200,000, of which $720,000 was received under the Hatch Act (in addition to $35,000 for this office) and $480,000 from State governments and other local sources. The number of officers had increased to 669.

With the increase in the number of the stations and the enlargement of their resources, there has been a corresponding increase in the number and variety of their publications, and these have been more thoroughly distributed each year. Besides the vast amount of agricultural information which has thus been generally diffused among our farmers, either directly through station publications, or indirectly through the public press, more than fifty books on strictly agricultural subjects have been written by station men during the past ten years, and the results of the work of the stations are being largely incorporated in books whose authors are not connected with the stations. It requires only a superficial retrospect to discover a very remarkable difference in the freshness of material and the thoroughness of treatment of the published information available to our farmers ten years ago and that which is at their command to-day. It is most encouraging to observe that, despite the pessimistic predictions in certain quarters, the output of carefully prepared books for the farmer's use has notably increased within the past few years, and American books for the American farmer are written from an American standpoint, and on the basis of accurate information obtained by American investigators.

SCIENTIFIC NOTES AND NEWS.

WE regret to record the death in New York on January 15th of Dr. Thomas Egleston, emeritus professor of mineralogy and metallurgy in Columbia University.

AT the January meeting of the American Academy of Arts and Sciences, Boston, Professor William M. Davis was chosen corresponding secretary in the place of Mr. Samuel H. Scudder, resigned.

M. MÉRAY has been elected a correspondent of the section of geometry of the Paris Academy of Sciences.

PROFESSOR RÖNTGEN, who has accepted the call to the University of Munich, has been appointed director of the State Institute of physics and metrology.

MR. W. N. SHAW, of Emanuel College, Cambridge, has been chosen to succeed Mr. Scott at the British Meteorological Office.

MM. RADAU AND BIGOURDAN have been presented by the Paris Academy of Sciences to the Minister of Public Instruction, who will select one to fill the vacancy in the Bureau des Longitudes, caused by the death of M. Tisserand.

PROFESSOR G. FREDERICK WRIGHT, of Oberlin College, has been given a leave of absence for a year and three months. He will make geologic studies in the Sandwich Islands, Japan, Russia, Egypt, Italy and other countries.

ON the twenty-fourth of December, 1899, the Physico-Mathematic Society, of Kazan, Russia, celebrated a jubilee in honor of the twenty-fifth year of professorial and scientific service of its President, Professor A. Vasiliev. It is also the fifteenth year of his presidency. Professor Vasiliev has been an important figure in Russian science. His discourse on Lobachevski has been translated into English by Professor Halsted, and a German translation of his book on 'Tchebychev' is to be published this month by Teubner at Leipzig. The first volume of an edition of 'Tchebychev's Collected Works,' in French, has just appeared, edited by the Academicians Markof and Sonine. It contains a fine portrait of the great mathematician and the first thirty-four memoirs of Vasiliev's list.

THE two books, Whitehead's 'Universal Algebra' and Killing's 'Einführung in die Grundlagen der Geometrie,' which were particularly signalized in Professor Halsted's Report on Progress in Non-Euclidean Geometry recently published in this JOURNAL, have been entered in competition for the Lobachevski prize of 1900.

THE American Society of Naval Engineers has awarded its first prize for the best technical essay submitted to Professor W. F. Durand of Cornell University, for his paper on 'Electrical Propulsion for Torpedo Boats.' The prize consists of a substantial compensation, life membership in the Society, and a gold medal. The second prize has been awarded to D. C. Ball, late of the Engineer Corps, and now a consulting engineer in New York, for his paper on 'Interior Diagrams for Multiple Expansion Engines.'

THE University of Lyons has received a legacy of 50,000 francs for the establishment of a prize to be awarded every five years to a resident of the city or neighborhood who shall have contributed to the advancement of hygiene or medicine.

M. BISCHOFFSHEIM has given to the Paris University the observatory established by him at Nice at a cost of 2,500,000 francs, together with an endowment of the same amount.

THE government has appropriated 13,000 Marks for mounting the 12-inch photographic telescope presented to the University of Heidelberg. Two thousand Marks have been given to the Scientific Society of Heidelberg for publication.

ANDREW CARNEGIE has promised the College of Emporia, Kan., $50,000 for a library building as soon as the present debt is paid.

DR. DOMENIK JOSEPH RITTER VON HAUSCHKA, formerly professor of medicine at Vienna, has died at the age of 84 years.

AT the last meeting of the Council, the Ottawa Field Naturalists' Club, Dr. Ami in the chair, the following gentlemen were nominated a committee of the Club on the Billings Memorial: Mr. J. E. Whiteaves, Sir James Grant, Dr. James Fletcher, Mr. Walter R. Billings, Mr. Byron E. Walker (Toronto), Mr. W. J. Wilson (Secretary of the Club), and Dr. H. M. Ami. A handsome sum of money has already been subscribed, and it is confidently expected that sufficient funds will be raised to pay suitable tribute to the memory of one who has done much to advance researches in paleontology and natural history in North America.

THE report of the Executive Committee of the New York Zoological Society shows that the Society has a total membership of 736, an increase of 136 over last year. The committee during the last year added $49,760 to the Park's fund, making $160,779 in all. The City had, however, cut the Society's allowance to $40,000 from $60,000. It was stated that the most pressing needs of the Society for new buildings could be met for $75,000. The following were elected members of the Board of Managers of the class of 1904: Ex-Gov. Morton, Andrew Carnegie, Morris K. Jesup, John L. Cadwalader, Philip Schuyler, John S. Barnes, Madison Grant, William White Niles, Samuel Thorne, H. A. C. Taylor, William D. Sloane, and Hugh J. Chisholm.

THE report of the Palisades Commission, which has been in communication with a similar commission from New Jersey, was made to Governor Roosevelt at Albany, on January 12th. It presents a bill providing for an appropriation of $250,000 to the National Government for Palisades Park purposes, in addition to land ceded in Rockland County. "While New York has a vastly greater material interest in the preservation of the natural scenery of the Palisades than has New Jersey," the commission says, "the former has offered to the National Government only an unimportant contribution in its very limited length of water front on the Hudson, while the State of New Jersey has offered to give property valued at upward of $750,000. It seems equitable that New York should tender in money what she lacks in land. With such an equalization of the burden, it is deemed not unlikely that all three parties may be brought into harmony in the carrying out of the proposition to preserve the Palisades."

THE sixth annual series of University Lectures in Biology, at Columbia University is being given by Professor Thomas H. Morgan, of Bryn Mawr College, on the subject of 'Regeneration and Experimental Embryology.' The dates and subjects are as follows: Jan. 16th, General Phenomena of Regeneration; Jan. 19th, The Conditions that Influence Regeneration; Jan. 23d, Special Problems of Regeneration and Development, Specification of the Tissues; Jan. 26th, Development of the Egg in the Light of Experimental Embryology; Jan. 30th, The Relations of Growth, Development and Regeneration. The lectures are given at 5 p. m. in Schermerhorn Hall. No tickets are required.

POSITIONS of library clerk in the Department Division of Forestry and of associate ethnologic librarian in the Smithsonian Institution will be filled by Civil Service examination during February. The position of assistant and expert in forestry history, at a salary of $1000 per annum, will also be filled in February as the result of an examination. Details regarding these, as of all other Civil Service examinations, can be obtained by addressing the U. S. Civil Service Commission, Washington, D. C.

AN examination will be held on February 6th for the position of draughtsman in the Geological Survey. The candidates should have experience in the preparation of drawings of invertebrate fossils.

THE Civil Service Commission of New York State will hold open competitive examinations on or about January 27, 1900, in various cities throughout the State, for the position of chemist, State Board of Health, with a salary of $125 per month. The examination will consist entirely of practical questions relating to analysis of food products, and questions relating to experience and training of the candidates; candidates having applications on file will be given ample notice of the time and place of examination most convenient to their places of residence.

A STATE department of Trade, Art and Commerce has been established for the Russian Empire.

THE Liverpool School of Tropical Medicine proposes to organize an International Conference on Malaria.

A CONGRESS on Tuberculosis will take place at Naples in the spring of 1900. The Congress, in connection with which there will be a great hygienic exhibition, is under the patronage of the Queen of Italy. Professor Baccelli, Minister of Public Instruction, will preside. A German committee has already been formed to assist in making arrangements for the Congress.

WE learn from the London *Times* that several prominent English medical men have been staying in Rome for some days. They visited the scientific and academic institutions and devoted special attention to the researches of Professors Grassi, Bignami, Celli and Dionisi, in connection with malaria. Arrangements were made for the maintenance of continual intercourse between the Roman School of Hygiene and the London School of Tropical Medicine. The English doctors visited various hospitals and conferred with the Minister of Public Instruction, who promised to be present at the official inauguration of the tropical school in London.

AT the annual meeting of the New York Neurological Society, held January 2d, the following officers were elected: *President*, Frederick Peterson; *First Vice-President*, Joseph Collins; *Second Vice-President*, L. Stieglitz; *Recording Secretary*, Pearce Bailey; *Corresponding Secretary*, Lewis A. Conner; *Treasurer*, Graeme M. Hammond; *Councillors*, C. L. Dana, M. A. Starr, B. Sachs, E. D. Fisher and J. Arthur Booth.

AT a meeting of the Zoological Society of London, on December 17th, Dr. P. L. Sclater, the secretary, read a report on the additions that had been made to the Society's menagerie during the month of November, 1899, and called special attention to two snake-fishes (*Polypterus senegalus*) from the river Gambia, obtained by Mr. J. S. Budgett, F.Z.S., during his recent expedition to the Gambia, and presented by him on November 22d. These were believed to be the first examples of this fish ever brought alive to Europe.

THE German Emperor began an address to the officers of Berlin garrison on January 1st with the words: "The first day of the new century sees our army," etc., and the day has been celebrated in Berlin as the first day of the twentieth century.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of the late Dorman B. Eaton, Columbia University receives $100,000 to found a professorship of municipal science and administration, and Harvard University $100,000 to endow a chair in the science of government.

MR. LOUIS H. SEVERANCE, of New York City, has given $60,000 to Oberlin College for a chemical laboratory. The provision made for the College by Mrs. C. E. Haskell amounts to $77,000.

DR. ALONZO E. TAYLOR, who, as we recently announced, has been called from the William Pepper Laboratory of the University of Pennsylvania to the professorship of pathology in the University of California, is at present in Berlin arranging for the purchase and construction of instruments for the new laboratories. Mrs. Hearst has provided for the equipment of the department of pathology, including bacteriology, general and special morphological pathology, and pathological chemistry, as also microscopes for the department of anatomy. The equipment of the department of pathology will be very complete and will provide especially for research work.

The sum of 17,000 Marks has been appropriated for apparatus for the new physical laboratory at Breslau.

The bequest of $25,000 by the late E. F. Holden to Syracuse University will be used for the department of astronomy and for the observatory.

Owen's College, Manchester, receives £1000 from the will of the late P. G. J. Ermen.

The medical faculty of McGill University is arranging courses on legal medicine and public health.

The College of Science of the University of Illinois has issued a circular offering a four years' course in natural science, the special object of which is to prepare for work in economic entomology. The principal studies of this course are three years' work in entomology (the last of which will be practically original research carried on under general supervision and advice), a year of chemistry, a half year of physics, mathematics and drawing, two years of German and one year of French, half a year of agriculture (agricultural crops), a year of horticulture (a three-fifths course), and a half year each of elementary biology, invertebrate zoology, human physiology, general botany, bacteriology and geology. To these are added, as minor courses, the military physical training, and rhetoric required for graduation. The courses in agriculture, horticulture and botany are so selected as to give the kind of knowledge and experience especially needed by the economic entomologist, and those in elementary biology and general zoology lay a foundation of training and instruction for the special studies of the entomological course. Students graduating from this course will receive the degree of B. S. in natural science.

The attendance of regular students at the University of Berlin this winter is 6478, which is an increase of 605 students over the registration last winter. The increase is the largest in the faculties of philosophy and law. The University of Berlin has more than three times as many students as it had twenty-five years ago.

The Rev. B. L. Whitman, D.D., since 1895 President of Columbian University, Washington, D. C., has resigned to accept the pastorate of the Calvary Baptist Church in Philadelphia. Dr. Whitman's resignation will take effect on June 1st, next.

Benjamin Lincoln Robinson, Ph.D., has been appointed Gray professor of botany at Harvard University.

Dr. Hans Stobbe has been promoted to an associate professorship of chemistry at Leipzig.

Dr. Luther has qualified as docent in physical chemistry at Leipzig and Dr. Ley in chemistry at Würzburg.

The Degree Committee of the Special Board for Physics and Chemistry, at Cambridge University, are of opinion that the work submitted by Richard Smith Willows, of Trinity College, advanced student, comprising papers (1) On the Variation of the Resistance of certain Amalgams with Temperature (*Phil. Mag.*, November, 1899); and (2) On the Distance between the Striæ in the Positive Column and other Phenomena connected with the Discharge, is of distinction as a record of original research.

Dr. J. Frischauf, professor of mathematics at Graz, has been suspended, apparently for criticising his colleagues in the newspapers.

The New York *Medical Journal* states that Dr. S. L. Schenk, professor of embryology and histology, and director of the Embryological Institute at the University of Vienna, has been retired on a pension. This action is in answer to a petition of the medical faculty of the university alleging the publication in the lay press of scientific theories constituting a form of advertisement. Dr. Schenk, it will be remembered, published a saccharine theory of sex production. He had been a director of the Embryological Institute for twenty-six years.

SCIENCE

FRIDAY, JANUARY 26, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N.Y.

THE INTERNATIONAL ASSOCIATION OF SCIENTIFIC SOCIETIES.

WE are able to publish through the courtesy of the President of the National Academy of Sciences, Dr. Wolcott Gibbs, the correspondence arranging for the conference of Scientific Societies held at Wiesbaden on the 9th and 10th of October, 1899. We hope to be able to publish later through the courtesy of Professor H. P. Bowditch, delegate from the National Academy of Sciences, an account of the Conference based on the official proceedings. It is scarcely necessary to call attention to the great importance of the plans of the Conference for the advancement of science and for the good understanding between nations to which the advancement of science is largely contributing.

THE ROYAL SOCIETY, BURLINGTON HOUSE,
LONDON, W., April 14, 1899.

SIR: The Royal Society has frequently had occasion to take action in respect to scientific undertakings calling for the coöperation of several countries, and undertakings of this nature show a tendency to increase. The experience of the Society has lead to the belief that it would be very advantageous to the interests of science generally if some machinery could be devised, by means of which suggestions made for international coöperation in scientific enquiries could be thoroughly discussed by the leading men of science from a purely scientific point of view, before definite proposals are made with a view to official action by the Governments of the countries concerned.

With this view, the Royal Society has communicated with the leading scientific Academies of Europe, whose replies give much encouragement to the idea that it may be possible to establish an organization, under which formal and regular meetings of representatives of all leading scientific Academies may be held for the purpose of discussing scientific matters calling for international coöperation, and by this means preparing the way for international action. The Council of the Royal Society regard this question as one of great importance, and I am to request you to bring it before your Academy, and to ask whether that body would be prepared to join such an organization if established, and to coöperate in arranging the details for inaugurating it upon a practical working basis.

I have the honor to be

Very faithfully yours,

(Signed) LISTER,

President, R. S.

THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES, WASHINGTON, D. C., U. S. A.

THE NATIONAL ACADEMY OF SCIENCES,
WASHINGTON, May 12, 1899.

SIR: I have the honor to acknowledge the receipt of your communication of April the 14th last asking me to bring before the National Academy of Sciences a plan to establish an organization under which formal and regular meetings of representatives of all leading scientific academies may be held for the purpose of discussing scientific matters calling for international coöperation and by this means preparing the way for international action.

There is no meeting of the National Academy of Sciences until the 14th of November next, but I will lay the matter at once before the Council of the Academy for consideration.

I cannot doubt that the subject will receive its warm approval and that the Academy, on the recommendation of the Council, will accept and cordially join in carrying out the plan proposed. I have the honor to be

Your obedient servant,

(Signed) WOLCOTT GIBBS,

President of the National Academy of Sciences.

THE PRESIDENT OF THE ROYAL SOCIETY,
LONDON, ENGLAND.

THE ROYAL SOCIETY,
BURLINGTON HOUSE, LONDON, W.,
May 31, 1899.

Sir: On the 17th November of last year the President of the Royal Society addressed a letter to the Academie des Sciences of Paris, the Reale Accademia dei Lincei of Rome, and the Academie Imperiale des Sciences of St. Petersburg, in reference to a proposal that the leading Academies should meet at intervals to discuss matters which might demand international cooperation; and a similar letter was subsequently addressed to the National Academy of Sciences of Washington.

The letter was written in consequence of what had taken place at a meeting of German Academies at Göttingen in June of that year, at which representatives of the Royal Society were present; and we have communicated to a meeting of the same Academies which has just been held at Munich the favorable replies which we have received from each of the Academies whom we had addressed.

We have now the pleasure to inform you that the invitation to a meeting at Wiesbaden, on October 9 and 10, which this letter accompanies, is a step towards carrying out the proposal in question, and we sincerely hope that your Academy will be able to take part in the meeting, which is intended to be a preliminary one for the purpose of discussing the mode in which such an Association of Academies can be best organized.

We are, sir,

Your obedient servants,

(Signed) M. FOSTER,
ARTHUR W. RÜCKER.

Secretaries, R. S.

THE PRESIDENT OF THE NATIONAL ACADEMY OF SCIENCES, Washington, D. C., U. S. A.

KÖNIGLICHE AKADEMIE DER
WISSENSCHAFTEN.
BERLIN, den 13, Juni, 1899.

Die Königlich Preussische Akademie der Wissenschaften in Berlin beehrt sich im Verfolg ihres am 1. ds. Mts. abgesandten Einladungsschreibens zu einer Conferenz in Wiesbaden am 9 und 10 October ds. Js. behufs Grundung einer internationalen Association gelehrter Gesellschaften anbei den von den Akademien in Berlin, Göttingen, Leipzig, München und Wien vorläufig vereinbarten Plan der Grundung ganz ergebenst zur Kenntniss zu bringen. Weitere Vorschläge über die Einzelheiten der Organization und Geschäftsführung, die als Vorlage zur Discussion auf der Wiesbaden Conferenz dienen sollen, wird unsere Akademie sich erlauben in kürzester Frist nachzusenden. Wir bitten aber uns schon jetst mittheilen zu wollen, ob die National Academy in Washington principiell geneigt ist an jenen Conferenz durch Absendung von Vertretern sich zu betheiligen und uns Namen und Adresse derselben bald gefälligst zur Verfügung zu stellen. DIELS,

Der vorsitzende Secretar.

AN DIE NATIONAL ACADEMY OF SCIENCES, WASHINGTON.

KÖNIGLICHE AKADEMIE DER WISSENSCHAFTEN.

BERLIN, den 24, Juli, 1899.

Die Königliche Akademie der Wissenschaften, welche die Delegirten Ihrer Akademie am 9. und 10. October auf der Conferenz in Wiesbaden zu begrüssen hofft, übersendet anbei 'Vorschläge zur Organization und Geschäftsführung,' die als Unterlage der Verhandlung dienen können. Genaueres über Versammlungsort und Stunde wird den Delegirten später direct mitgetheilt werden. Zu diesem Zweck ersucht die Akademie Namen und Adresse der Delegirten bis spätestens Ende September an das 'Bureau der Königlichen Akademie der Wissenschaften' Berlin N. W. Universitätsstrasse 8, gefälligst einsenden zu wollen.

Zum Schluss beehrt sich die Akademie mitzutheilen, das sie ihrerseits ihre Mitglieder die Herren Auwers, Virchow und Diels zur Conferenz delegirt hat. DIELS,

Der vorsitzende Secretar der Königlich Preussischen Akademie der Wissenschaften.

AN DIE NATIONAL ACADEMY OF SCIENCES, WASHINGTON, D. C., U. S. A.

KÖNIGLICHE AKADEMIE DER WISSENSCHAFTEN.

N. W. 7 Universitätsstrasse 8.

BERLIN, den Juni, 1899.

Die Königlich Preussische Akademie der Wissenschaften in Berlin beehrt sich im Auftrage der am 23. Mai ds. Js. in München versammelten deutschen Akademien und in Einverständniss mit der Royal Society, deren Regleitschreiben beigefügt ist, die National Academy, Washington, zum Zwecke der Gründung einer internationalen Association gelehrter Gesellschaften auf den 9. und 10. October ds. Js. nach Wiesbaden zu einer constituirenden, Conferenz einzuladen.

Diese Einladung ergeht gleichzeitig an die Königlichen Gesellschaften der Wissenschaften zu Göttingen und Leipzig, Königliche Akademie der Wissenschaften in München, Académie des Sciences in Paris, Kaiserliche Academie der Wissenschaften in St. Petersburg, Reale Accademia dei Lincei in Rom, National Academy in Washington, Kaiserliche Academie der Wissenschaften in Wien.

Der Zweck der Association ist, wissenschaftliche Unternehmungen, welche von der Gesammtheit der vereinigten Körperschaften oder von einer Gruppe derselben oder von einer einzelnen derselben in Angriff genommen oder empfohlen werden, zu unterstützen und sich über Einrichtungen zur Erleichterung des wissenschaftlichen Verkehrs zu verständigen. Jeder einzelnen Körperschaft soll die Entschliessung über die Theilnahme sowie über Mittel und Wege von Fall zu Fall vorbehalten sein.

Es wird Aufgabe der Wiesbaden Conferenz, sein, Organization und Geschäftsordnung dieser Association zu berathen und über etwaige Aufnahme anderer gelehrter Gesellschaften Beschluss zu fassen. Ein genaueres Programm wird binnen kurzem den eingeladenen Academien zugestellt werden.

Vorläufig wird aus den zunächst fur die Wiesbaden Conferenz geltenden Bestimmungen mitgetheilt, dass jede Academie eine beliebige, nach ihrem Ermessen zu bestimmende Anzahl von Vertretern entsendet, die Abstimmungen jedoch nach Academien stattfinden. Die Sprache der Verhandlungen ist frei. Die Protokolle werden deutsch, englisch und französisch geführt.

Es wird in Aussicht genommen auf diese constituirende Conferenz in Weisbaden die erste Arbeitsconferenz der Association im Jahre 1900, und zwar in Paris, folgen zu lassen.

Nach Eingang der in Aussicht gestellten Bestimmungen und Vorschläge bitten wir eine Erklärung über die Beschickung der Wiesbaden Conferenz unter Mittheilung der Namen der Delegirten an unser oben angegebenes Bureau gelangen zu lassen.

Diels,
Der vorsitzende Secretar.

PLAN FOR THE FOUNDATION OF AN INTERNATIONAL ASSOCIATION OF LEARNED SOCIETIES, SUBMITTED BY THE ACADEMIES AT BERLIN, GÖTTINGEN, LEIPZIG, MUNICH AND VIENNA.

1. The formation of an International Association of the larger learned Societies of the world is regarded as expedient and as likely to prove of service to the advancement of science.

2. The object of this Association is to support scientific enterprises undertaken or recommended by the united Societies in common, or by a group of the same, or by any individual Society, and, further, to make arrangements for facilitating international scientific intercourse. Each Society shall, as regards any particular undertaking, reserve to itself the right of deciding whether it will participate or not.

3. At the conference to be held at Wiesbaden the organization of the Association and its business details will be more fully discussed, deciding at the same time, whether periodical meetings say every three or five years, shall be held, or whether such meetings shall take place at irregular intervals, as occasion requires.

4. The resolutions of the Wiesbaden Conference will be submitted to the individual Societies for their approval and sanction. The Societies will then, by the end of the year 1899, definitely inform some central authority appointed by the Conference, whether they intend or not to join.

5. Each Society is free to withdraw from the Association at any time.

6. The Royal Academy of Sciences (Berlin), in conjunction with the Royal Society (London), has invited the following bodies (here arranged in alphabetical order) to attend the Wiesbaden Conference:

1. Königliche Gesellschaft der Wissenschaften at Göttingen.

2. Königliche Gesellschaft der Wissenschaften at Leipsic.

3. Königliche Akademie der Wissenschaften at Munich.

4. Académie des Sciences at Paris.

5. Académie Impériale des Sciences at St. Petersburg.

6. Reale Accademia dei Lincei at Rome.

7. Kaiserliche Akademie der Wissenschaften at Vienna.

8. National Academy at Washington.

7. The question of the eventual admission of other Societies will be discussed at the Wiesbaden meeting.

8. Each body will exercise its own judgment concerning the number of representatives to be sent to Wiesbaden. At the voting the representatives of each Society will have but a joint vote.

9. The language to be used at the Conference will be optional: the minutes will be drawn up in English, French and German.

10. The Royal Society proposes that the first official meeting of the Association be held in the year 1900, in Paris.

All communications referring to the Wiesbaden Conference are to be directed to the 'Bureau der Königlichen Akademie der Wissenschaften,' Berlin, N. W., Universitätsstrasse 8.

PLAN FOR THE ORGANIZATION OF AN INTERNATIONAL SCIENTIFIC ASSOCIATION PRESENTED BY SIR MICHAEL FOSTER AND DR. H. P. BOWDITCH.

1. The members of the National Academies mentioned in the 'plan for the foundation of an international association of learned societies' (Berlin, June, 1899), together with those of such other Academies as may be chosen by a majority vote of the Academies represented at the preliminary conference in Wiesbaden in October, 1899, shall constitute an International Scientific Association.

2. The first meeting of the Association shall be held in Paris in 1900, and its subsequent meetings shall be held at such times and places as may be then or thereafter determined.

3. By a two-thirds vote of the Association, each Academy voting as a unit, representative Academies of other nations may be admitted to membership in the Association.

4. The objects of the Association are :

(*a*) To promote and make preliminary preparations for work requiring international coöperation for its prosecution.

(*b*) To facilitate intercourse, both professional and social, between scientific men of all countries.

5. The governing body of the Association shall be an International Council composed of one representative from each constituent Academy.

6. The Council shall hold its first meeting at such time and place as may be determined at the meeting of the Association in 1900, and shall make rules for its own organization and guidance, including the transaction of business by correspondence.

7. For the purpose of considering and framing recommendations concerning scientific enquiries calling for international coöperation special International Committees shall, upon recommendation of one or more constituent Academies, be instituted either at a general meeting of the Association, or when necessary during the intervals between such meetings, by the International Council.

8. Such International Committee shall consist of delegates appointed by the constituent Academies with special reference to their qualification to deal with the questions under consideration.

9. The first meeting of such a Committee shall be called by the President of the International Association or by the President of the Council, and at this meeting each committee shall adopt rules for its own guidance.

10. Each International Committee shall make a report embodying such recommendations as it may think advisable, to the President of the International Council who shall transmit the same to the constituent Academies.

11. The President of the Council shall, however, have power, if he see fit, before transmitting such reports to the constituent Academies, to submit the same to the Council, and this body shall have power to refer back the report to the committee for further consideration.

12. For the transaction of business, the President of the Council shall be authorized to employ a secretary whose compensation, as well as other necessary office expenses, shall be provided for by contributions from the constituent Academies.

DELEGATES TO THE WIESBADEN CONFERENCE, OCTOBER 9 AND 10, 1899.

1. Königlich preussische Akademie der Wissenschaften, Berlin : Auwers Virchow, Diels.

2. Königliche Gesellschaft der Wissenschaften, Göttingen : Ehlers, Leo.

3. Königlich Sächsische Gesellschaft der Wissenschaften, Leipzig : Windisch, Wislicenus.

4. Royal Society, London : Sir M. Foster, Rücker, Armstrong, Schuster.

5. Königlich Bayerische Akademie der Wissenschaften, München : von Zittel, Bechmann, Dyck, von Sicherer.

6. Académie des Sciences, Paris: Darboux, Moissan.

7. Kaiserliche Akademie der Wissenschaften, St. Petersburg : Famintzine, Salemann.

8. National Academy of Sciences, Washington : Newcomb, Billings, Remsen, Bowditch, Bell.

9. Kaiserliche Akademie der Wissenschaften, Wien : von Hartel, Mussafia, von Lang, Lieben. Ersatzdelegirte : Gomperez, Toldt.

BLUE FOX TRAPPING ON THE PRIBILOF ISLANDS.

THE value of the Blue Fox, *Vulpes lagopus*, as a fur-bearing animal, has caused the establishment of various 'fox farms' or 'ranches,' not only on the islands of the northwest coast, and especially in the Aleutian chain, but even on some of the islands off the coast of Maine ; and it is naturally desirable to ascertain how these may be made to yield the best results. The problem of the 'fox farmer' is to obtain the greatest number of skins in a given season without so reducing the breeding animals as to lessen the catch for the succeeding year. Natural losses, due to starvation, may be prevented by feeding, but as foxes are naturally monogamous, it is evidently necessary to render them polygamous in order to render fox-raising a decided success, and this is the great desire of the trappers.

On the Pribilof Islands, in Bering Sea, the Blue Fox has been trapped continuously for a long series of years, but not until recently has any attempt been made to study these animals with the view of not only systematically feeding and trapping them, but of endeavoring to effect such changes in their environment as would tend to make them polygamous. This attempt has been made by Mr. James Judge, who has for several years been Treasury Agent on the island of St. George, who has taken much interest in the fur seal and fox question, and to whom the information contained in this article is entirely due. From its isolation, its hilly, rocky character, and from the vast numbers of birds which resort to it for a breeding place, this island is admirably suited for the abode of the fox, the great drawback being the lack of food during the winter. This lack of food not only acts directly on the foxes by starving them, but causes them to abandon the island and go out on the floe ice whenever this drifts down upon the island, as it often, or usually does in early spring. In summer the foxes feed upon birds and eggs and to some slight extent, upon dead seal pups and the placenta dropped from those recently born. The bodies of the seals on the killing grounds are eaten to some extent, but these bodies rapidly decay, and besides during the killing season the supply of other food is most abundant.

Since the advent of pelagic sealing the foxes have had an abundant, though brief, supply of food in the fall in the shape of the seal pups whose mothers have been taken at sea, and who have starved in consequence. In 1896 every starved pup was devoured by the foxes, so that no actual count of them could be made, but from an estimate made by comparison with the known facts on St. Paul Island, their number was probably considerably over 2000, while in previous years it was much greater. The foxes have fed to some extent on the Pribilof Lemming, *Lemnus nigripes*, and seem to have nearly exterminated the little creature, since but one specimen was seen in 1896–97. In winter the foxes eat anything that comes to hand, extraordinary as it may seem, subsisting to a considerable extent on sea urchins, *Strongylocentrotus drobachiensis*, which are gathered at low tide. Considerable grass is found in their stomachs in winter and some worms, which they scratch up on the killing grounds, as well as with a few tunicates and an occasional fish bone; but it may be said that in winter the foxes lead a precarious existence. Some not very energetic attempts have been made to introduce the Cottontail Rabbit on St. Paul Island, and the Cottontail and Jack Rabbit elsewhere, but so far without success; the proposed introduction of the Spermophile, *Spermophilus empetra*, which is found at Unalaska, would probably succeed better.

On the Aleutian Islands dried salmon has been used for feeding the foxes in winter, and on St. George the experiment was also tried of using cracklings and linseed meal. This latter was evidently not to the foxes' taste, but it was found that by mixing the meal with seal oil it was eagerly devoured. In 1897 Mr. Judge decided to use the carcasses of the fur seals taken for skins, but as the catch on the Island of St. George has of late years become so small that the bulk of the meat is eaten by the inhabitants, a number of bodies were salted and brought over from the neighboring island of St. Paul. Mr. Judge tried the experiment of putting down fresh carcasses in silos, as well as of salting them, and this plan has, with one exception, been entirely successful. The exception was when some seventy foxes effected an entrance into one of the pits, where they feasted to such an extent before being discovered, that a few died. The salted bodies were freshened by protracted soaking before being fed to the foxes. As the trapping season drew near these carcasses were placed at night in the vicinity of one of the sheds, near which it was proposed to set traps, and, starting with four bodies, the number was increased as found necessary, until no less than ten were consumed each night.

When all was ready trapping was begun, box traps being used, in order that the foxes taken might be examined to ascertain their sex, the dead falls formerly employed killing whatever entered, regardless of sex or condition. All females were turned loose after being marked by clipping a ring of fur from the tail, an exception being made when white foxes were caught, all of these being killed in the endeavor to produce a breed none of which should turn white in winter.

As the use of box traps proved to be somewhat slow, a small enclosure, or corral, was hastily constructed adjoining a large shed, and so arranged that the entrance could be readily closed by a man stationed within the building. This plan proved an immediate success, the foxes entering the enclosure without hesitation, so that from five to forty could be taken at one time. Having been shut in the corral the animals were driven through a small door cut in the side of the shed into a room where they were caught by means of forked sticks pressed over their necks, these being superseded by boards with a U-shaped opening in one end. The foxes were then passed, one at a time, through a small door into a second room, where they were received by a gang of men and examined as to sex. The females were all released, while the majority of the males were killed by breaking their necks, the intention being to leave one male to every three females. All foxes liberated were marked as previously noted, and this mark was repeated whenever an individual was captured more than once, with the result that by the end of the season some animals had lost most of the fur on their tails.

The possibility of rendering the foxes polygamous remains to be seen, and it will naturally take a series of careful observations extending over a number of years to definitely determine this point. At present it can only be said that the catch of the second season on St. George did not fall below that of the first, and some observations show that the male foxes will have intercourse with more than one female, while the bringing together of the animals that would, under natural conditions be widely scattered, is a most important factor in rendering them polygamous. The curious fact presents itself that in every instance save one, the number of males taken exceeded that of the females, even towards the close of the trapping season, but it is, of course, possible that this may be due to the attraction of the females for the males and not to any excess in the birthrate of the latter.

Mr. Judge's observations have made it clear that the foxes have no predilection for any particular locality, the question of food being the main factor in determining their distribution. This was proved by trapping at various parts of the island, the result being that comparatively few animals were taken save at the village, while those caught at one locality would subsequently be taken at another. Consequently by judicious baiting they can be readily enticed from all parts of the island to the vicinity of the village, where they can be taken by wholesale, in such manner that the total number of foxes on the island can be pretty nearly ascertained, as well as the proportions of the sexes. The blue foxes seem to lack the proverbial craft of the other species, for not only did they readily enter the pen, but, as shown, by the marks, they entered again and again, some individuals being captured no less than five times, while a few were taken twice in succession at intervals of about ten minutes. That the scent of man about the corral should not deter the foxes from entering is not surprising, since, except during the trapping season, they have no cause to fear him. Such precautions as that of taking the animals out in a boat so that they may be killed over water seem rather absurd, the more that when pressed by hunger they will even devour the skinned bodies of their own species. One piece of information desired, as to whether or not the foxes would wander off on the ice floes when they were being fed, has not yet been obtained because, curiously enough, during the two years that the experiment has been made the ice has not happened to touch St. George.

Incidentally Mr. Judge has made observations on the food, size and condition of foxes, and has shown that the pelt does not improve with age, as has commonly been stated, but that the yearlings and two-year-olds have the best fur. As for weight, the smallest fox weighed a little over eight pounds, the largest a trifle more than fourteen, the great majority weighing in the vicinity of ten pounds.

The outcome of these experiments will be awaited with much interest, and if by a little artificial selection and environment a naturally monogamous animal can be rendered polygamous, the supply of blue fox furs will be materially increased.

The table appended gives the results of the catch for the season of 1898–99, and the total number of animals must seem rather surprising to one familiar with the island.

It only remains to add that the greatest number taken in any one evening was 245, of which 61 were killed; the second best night's work was 211, and of these 57 were killed.

Foxes taken on St. George during the season of 1898–99:

Male Blue Foxes trapped and killed	334
Male Blue Foxes otherwise killed	34
White Foxes killed, males and females	18
Male Blue Foxes trapped and released	110
Female Blue Foxes trapped and released	389
Total	885

F. A. Lucas.

THE DEEP WELL AT WILMINGTON, N. C.

The deep well which is now being bored at Wilmington, N. C., is of especial interest to geologists: (1) That in reaching granite, as it does at about 1109 feet, it shows the absence at this point of formations between the upper Cretaceous and the old crystalline floor underlying the coastal plain deposits; (2) it shows the existence there of an unfortunately and unusually thick series of salt-water-bearing strata, from 350 to 1100 feet below the surface; (3) it may throw some light on the relations between the deposits of the sand hill regions (generally classed as Potomac) and the upper Cretaceous beds penetrated by this well.

The well is located on the bank of the northeast Cape Fear river, at Hilton Park, one mile north of Wilmington. The river border at this point exhibits two terraces; one only a few feet above tide water, extending back a distance of 30 or more feet from the river; and the other rising 30 to 40 feet higher, extending back for a considerable distance, and indeed representing the general surface of the region. The difference in elevation between these two terraces represents the thickness of the remnants of the Tertiary fossiliferous clays and limestone and the overlying recent sands. The lower terrace represents the upper surface of the Cretaceous; so that the well starts in the Cretaceous clays and sands, and continues in them to a depth of some 1109 feet. In these sands and clays there are occasional beds of shell-rock and calcareous sandstone varying in thickness from a few inches to 30 feet, and occasional thin beds of clay containing small nodules or concretions. The sands are mostly micaceous and are usually quite fine grained, with a prevailing gray color. From about 700 to 800 feet, their color is decidedly greenish. Below 950 feet these sands become coarser and are interbedded with occasional gravel deposits, but they continue fossiliferous to near the surface of the granite.

Waterbearing sands and gravels were penetrated at a number of points, notably at 380, 496, 520 and 574 feet; and at 1011 the largest flow, of nearly 400 gallons per minute, was encountered, with pressure estimated as sufficient to raise the column of water 80 feet above the surface. Unfortunately the water from each of these levels was highly brackish, and hence unfit for domestic use.

The fossil forms secured at different depths have been identified by Dr. T. W. Stanton, of the United States Geological Survey. The method used in sinking the well is the ordinary drill and sand pump; and, as might be expected, in some cases only fragments of shells were secured; but as the hole was of large diameter (12 inches near the surface, then 10 inches, and lower still, 8 inches) and the larger part of the matrix material quite soft, a minimum amount of drilling was needed; and many large fragments and many perfect forms were obtained.

Among the fossils secured from the upper 700 feet, classed as Ripley cretaceous, the following may be mentioned:

Cardium eufaulense Gabb, was found at 40 feet and 538–558 feet, and fragments of this or another Cardium were found also at 50, 485–490, 520–540 and 556–575 feet below the surface.

Anomia argentaria Morton, was also common, having been obtained at frequent intervals from 40 to 600 feet; and fragments of an *Anomia*, too small for specific classification, were also found 800 to 900 feet below the surface.

Exogyra costata Say, was abundant throughout the upper half of the section; and below 500 feet a varietal form of this species, approaching *Exogyra ponderosa* Roemer in surface feature, was found almost to the granite.

Ostrea tecticosta Gabb, was common from 230 to 650 feet; and *O. larva* Lamarck, from 250 to 330 feet; and fragments secured at 518 feet probably belonged to one of these species. *O. subspatulata* Lyell & Forbes, was found only between 332 and 380 feet. Throughout the entire section, however, were found numerous fragments of *Ostrea* too imperfect to serve for specific determinations. *Veleda lintea* Conrad, and *Aphrodina tippana* Conrad (?) were found only at 340 to 500 feet. *Baroda Carolinensis* Conrad, and *Cyprimeria depressa* Conrad, were found only between 332 and 380 feet; and fragments of *Pecten* were found at 40 to 50 feet.

Gryphaea vesicularis Lamarck, was found at 250 to 265, and 720 to 735 feet (?); and *Inoceramus cripsii* Mantell, at 575 to 585 feet and probably also at 500 to 518 feet. Unrecognized species of *Avicula* or *Gervillia* were obtained at 390 to 400 feet; *Corbula* at 492 feet; *Pectunculus* 520 to 540 feet, and *Lunatia* 520 to 590 feet; *Lithophagus* 540 to 560 feet.

Cassidulus subquadratus Conrad, was observed at 518 to 538 feet, and echinoid spines and fragments of the same or allied species were also found at 100 to 170 feet. Sharks teeth, fish vertebræ, fragments of turtle shell, lignite and pyrite were found at intervals in the section.

Below 720 feet, and down to the granite (1109 feet) *Ostrea cretacea* Morton, which in the Chattahoochee river section is confined to the Eutaw beds, is here quite common; and is accompanied at intervals by *Anomia Exogyra*, *Cardium* and *Serpula*, the specimens collected being in each case too fragmental to permit of specific determination. This lower 400 feet of the Wilmington section has been classed by Stanton as *Eutaw*; and it is possibly the seaward representative of the Potomac arkose sands and clays of the sand-hill region northwest of Fayetteville, should these sands and clays prove to represent the latest Potomac. It is more likely, however, either that the Potomac deposits were removed from this region prior to the Eutaw deposition, or else that the surface of these old crystalline rocks was above water level during Potomac time, and hence not covered with deposits.

Underground temperatures were not taken at intervals at different depths while the work was in progress, owing to the lack of suitable thermometers; but there are now three wells only three or four feet apart, one 1100, one 500 and one 100 feet deep. The temperatures at the bottom of each of these, as determined by the use of a Darton deep well thermometer, were found to be 79°, 72.50°, and 68.50°F. respectively, giving a descending increase in temperature of about 1°F. for each 100 feet, between 100 and 500 below the surface; and 1°F. for each 98 feet, between 500 feet and 1100 feet below the surface.

J. A. Holmes.

Chapel Hill, N. C.

GRANITES OF THE SIERRA COSTA MOUNTAINS IN CALIFORNIA.

The Sierra Costa mountains occupy mainly the northeastern and northcentral portions of Trinity county, in northwestern California. They are the loftiest and most scenic portion of the Klamath mountain system, an off-shoot of the Sierra Nevadas. They consist, in general, of highly metamorphic clastics and ancient igneous rocks, including a basement crystalline formation, a massive serpentine, and a series of micaceous, chloritic, graphitic and hornblendic schists. All these are pre-Carboniferous in age; they have been subjected to intense orographic disturbance, folded and faulted on a grand scale, and into the fissures have been injected various granitic and dioritic dike rocks. Of these, granite, in hugh batholites, is by far the most important and bulky.

Three principal types of granite are represented, and they present some interesting contrasts: hence this paper.

On the western side of the head-water portion of the south fork of the Salmon river in Siskiyou county, there is a huge white mountain of nearby bare granite—Mt. Courtney of the Cariboo range. It is a massive batholite of true granite, consisting of large individuals of quartz, white feldspar and dark brown biotite, *but little or no hornblende*. It is very coarse-grained, the three rock species being crystallized on a scale of one-fourth inch. The color is a very light gray, as a soda-feldspar is a predominant constituent.

The Courtney granite abounds in vein-like dikes of aplite, a much finer grained white granite, in which the biotite is in small foils and sparingly developed. The contrast between the massif of very coarse-grained granite and the included dikes of fine-grained aplite is strong. Evidently they both represent the same magma, but it seems that after the coarse granite mass had solidified in its upper portion, great fissures were formed in it and the aplite arose in them, solidifying to form the curious dikes of white granite. The former is coarse-grained, because, being in one great mass, it cooled slowly, and the latter is fine-grained, because, being in thin dikes widely scattered through an already solid rock, it cooled rapidly.

Near the contact between the Courtney granite and the hornblende schists on the east, both granite and schist are cut by dikes of a white muscovite granite, a kind of fine-grained pegmatite. This contains neither biotite nor hornblende, and is more resistant to weathering influences than the other granites of this area. These pegmatite dikes are cut by a transverse system of dikes of dark green diorite-porphyrite, which also occurs in the coarse-grained biotite granite of Mt. Courtney, as well as dikes of very fine-grained light greenish gray diabase.

On the east side of the head of south fork of Salmon river, about three-fourths of a mile distant from Mt. Courtney, there is another granite batholite but it is composed of an entirely different type of granite. It contains the ordinary quartz, feldspar and biotite, but in addition, *it abounds in well-formed crystals of dark green and black hornblende.* The feldspar being largely plagioclase, it is a quartz-mica diorite, although its general appearance in the field is distinctively that of a granite. In fact, it is the rock commonly designated, by students of the Sierra Nevada region, granodiorite. It is finer grained and a darker gray in color than the Courtney granite.

This massif of granodiorite is at least a mile in length and one-half mile in width. It is one of a series of such granite masses scattered through the Sierra Costa mountains eastward from Mt. Courtney, some of which are as much as three miles in width. They all contain the large constituent of hornblende, and are characterized by spots of darker color, like included boulders of diorite-porphyrite, but which are probably concretionary in origin.

It is difficult to comprehend how such great masses of granite could be injected into the stratigraphic series, displacing the strata for miles. Mt. Courtney is but one of a series of high granite peaks extending southwest from it and apparently consisting of the same great massif of coarse-grained biotite granite, which may be ten miles or more in width. The strata of serpentine and schist must have been forced apart and up into high mountain masses, of which even Mt. Thompson, altitude 9345 feet, is but an insignificant remnant.

Between Mt. Courtney and the massif of granodiorite about three-fourths of a mile east of it, there is a block of mica and hornblende schists wedged in between the two granite masses. This dips steeply eastward, away from the Courtney granite and toward the granodiorite. As it approaches the latter it becomes nearly vertical, but the strata are cut off by the granodiorite. The contact is finely exposed and shows no contact metamorphism. The dark green hornblende schists are absolutely unchanged to the very contact. Fragments of all sizes up to 100 cubic feet, of the hornblende schist are included in the granodiorite from the contact in places, 100 or more feet distant. Some portions of it are a veritable breccia of schist cemented by granodiorite.

Now, the edges of all fragments are sharp and the corners angular. Nowhere is there the least evidence of partial fusion of the schist material even along the edges, by the heat of the great mass of 'melted' granodiorite in which it had become included. If the latter was *very* hot, it appears evident that during the long time which such a great mass must have required in cooling, the hornblende and quartz, of the schist fragments must have partially fused. The failure of this to occur to even the slightest degree, implies, in my mind, that the granodiorite was not very highly heated—not nearly so much so as other dike rocks of the same region. Yet that it was in a highly liquid condition is proved by its injection into the finest cracks of the adjoining schist. In short, I believe there is here abundant evidence to demonstrate a perfect fusion without great heat, a sort of 'wet fusion,' we may suppose, due to the presence of heated alkaline waters. The fragments of hornblende schist were impervious to this water, the heat not sufficient to produce a 'dry fusion,' and hence the present phenomena, described above. As this locality may prove a very interesting one to students of igneous geology, I will give it as the vicinity of Lake Catrina, on the mountain ridge just east of the head of the south fork of Salmon river.

The age of all the granites of the Sierra

Costa mountains is practically the same. They belong to a period of orographic disturbance during which the intrusives were predominantly granitic in distinction from an earlier diabasic and a later dioritic period of igneous activity. This granitic period was post-Carboniferous and pre-Tertiary. To make a finer distinction, many of the granodiorite dikes can be demonstrated to have been formed after the Mariposa slates of late Jurassic age (which they cut), and before the Shasta-Chico shales and sandstones of late Cretaceous age (which lie upon their eroded surface).

An interesting problem yet to be worked out is the relation between the biotite granite of Mt. Courtney and the granodiorite of the mountain country to the eastward. Why two such strongly contrasted granites of apparently about the same age and mode of formation should occur in such close juxtaposition as the Courtney and Catrina batholites on opposite sides of the valley at the head of the south fork of Salmon river, is to me a puzzling problem and one well worth considerable study.

Oscar H. Hershey.

AMERICAN PSYCHOLOGICAL ASSOCIATION.

The eighth annual meeting of the Association was held at Yale University, December 27th–29th, in affiliation with the American Society of Naturalists. In point of numbers and activity the meeting was one of the most successful in the history of the Association. Professor John Dewey, of Chicago, the President of the Association, was present in the chair, and on the afternoon of Wednesday, the 27th, read his presidential address on 'Psychology and Social Practice,' in which he discussed the relation of psychology to education considered as a form of social practice with which psychology might be expected to have most immediate concern, and then generalized the results reached to draw certain conclusions regarding the general value of psychology as a method to be applied in social life. (The address will appear in full in the March number of the *Psychological Review.*)

Following the address a formal discussion on 'How should psychology be taught?' was opened by Professor Fullerton, of Pennsylvania, who laid particular stress upon the question of the adjustment of the relative claims of the so-called 'new' psychology or psychology of the laboratory and the 'old,' which depends largely upon introspective analysis. He emphasized the necessity of both aspects in a general course, as well as the danger of giving undue prominence to either, and particularly, in America, to the experimental, owing to the tendency to extreme specialization in the subject in this country. Professor Fullerton further discussed the attitude which the university should take toward advanced students in the light of their future work. Professor Jastrow, of Wisconsin, continued the discussion and urged the importance of what he termed a 'functional' psychology in teaching, having the student verify facts and principles from his own experience, so far as possible from his own daily mental processes. He showed further the great value which experimental experience has for the introspectionist and agreed with the former speaker in deploring the quasi-antagonism of the two sides, arguing that both experiment and introspection are necessary and that they are complementary and in no way antagonistic. Professor Aikins, of Western Reserve, followed with a statement of the results of his own experience in teaching the subject, and described his method of combining experiment and text-book with collateral conferences. Professor Judd, of New York, closed the formal part of the discussion by calling attention to the peculiar difficulties encountered by the student of psychology due to the nature of the subject matter, the difference between observation and interpretation, and his questioning of inferred facts owing to the indirect method of arriving at them. The speaker argued that the difficulty is best avoided by first studying the indirect modes of treating subjective experience, that is, by a study of the physical and physiological conditions of mental life, always keeping in view its relation to the final treatment of mental experience toward which it is aiming. The discussion was continued informally by a number of the members from the floor.

The general program was long and varied. On Wednesday morning Professor E. F. Buchner spoke on 'Volition as a scientific doctrine,' and Professor G. S. Fullerton on 'The criterion of sensation' continuing a discussion developed in a paper on 'The psychological standpoint,' read before a former meeting of the Association, which endeavored to show what is implied in the recognition of psychology as a natural science. This was followed by what proved to be one of the most interesting papers of the session, viz., 'A new arithmetical prodigy with demonstration' by Professors E. H. Lindsay and W. L. Bryan. The subject is a boy, nineteen years old, the son of a stone mason, who has attended school seven years, made a fair record in all his studies and is of good general intelligence. Since the age of three he has shown a passion for numbers and has developed extraordinary powers in calculation. Since November, 1899, he has been under investigation at Indiana University. This investigation has been general and thorough and is still being carried on. The principal results thus far are as follows: In scope and tenacity of memory and in rapidity he ranks among the best recorded cases. He is unique in the large number of methods which he has worked out, and in the fact that he explains how and when he arrived at these. His rapidity is found to depend upon the great number of number relations committed to memory and upon the reduction in the number of operations through short-cut methods. The boy was present and gave demonstrations of his powers on both Wednesday and Thursday mornings, which were followed with great interest.

Professor W. S. Monroe closed the first session with a paper on 'Moral perceptions of school children,' describing an experimental investigation.

On Thursday morning the Association divided into sections, one for experimental reports and one for papers of more purely philosophical scope. Owing to the length of the program this sectional division was continued up to the end of the meeting. The experimental section on Thursday was opened by Professor E. A. Kirkpatrick on 'Individual tests of school children.'

Dr. T. L. Bolton spoke on 'The Reliability of certain methods for measuring the degree of fatigue in school children,' criticising the method of Griesbach with the æsthesiometer and the application of the ergograph to determine the fatigue value of subjects of the school curriculum. The speaker described experiments of his own, and reached conclusions unfavorable to the methods named. Professor E. F. Buchner described in detail 'A new number form,' and Dr. Robert MacDougall followed with a paper on 'The time values of accented and unaccented elements in rhythm.' Professor Chas. H. Judd described 'A method of securing enlarged records of voice vibrations' on smoked paper by means of an arrangement of two diaphragms. Records made were exhibited, and a detailed analysis of a four-syllable word was reported. Dr. E. W. Scripture reported on 'Researches in experimental phonetics. Dr. Max Meyer spoke on 'Elements of a psychological theory of music,' criticising sharply the current theories and insisting particularly upon the necessity of the number 7 in a scientific theory of music.

Dr. A. H. Pierce closed the session with a paper 'Is there an independent auditory space?' The speaker argued for the affirmative, basing his conclusion upon the phenomena of 'intra-cranial localization' occurring when two fusing sounds are given simultaneously, one at each ear, the resultant reference to the interior of the head being a genuine auditory phenomenon and not a localization made by the aid of factors borrowed from the visual or tactual space fields.

In the meeting of the philosophical section, held simultaneously with the foregoing, papers were read as follows: Professor E. H. Griffin, 'The natural history point of view in psychology'; Professor J. H. Hyslop, 'Kant's doctrine of apperception and the use of the categories'; Professor William Caldwell, 'Pragmatism'; Professor J. A. Leighton, 'Metaphysical method'; Professor Alexander Meiklejohn, 'The concept of substance.'

On Thursday afternoon the psychologists adjourned to meet with the naturalists for their annual discussion, Professor Jastrow representing the Association.

At the meeting of the experimental section on Friday morning, the first paper was by Mr. Clark Wissler on 'Some experiments on motor diffusion.' Mr. Wissler reported experiments showing the time relation between the primary, voluntary contractions of finger muscles and the accompanying secondary, unintentional contractions of the other arm muscles, the latter being due to a diffusion of the motor discharge. Primary contractions are first in order of time and are followed by secondary contractions in an order corresponding to their distance anatomically from the muscle innervated. Further, training finger muscles trains other arm muscles and training biceps trains finger muscles. Secondary contractions also take place on opposite side of the body. He argued that transference of practice effect is simply the result of diffused nerve currents.

'The influence of special training in general ability' was the subject of a paper by Drs. E. L. Thorndike and R. S. Woodworth. Experiments were reported in which special abilities were studied as follows: (1) The speed and accuracy of making certain complex observations, *e. g.*, of picking out from a page of print all the verbs or all the words containing both *r* and *e*, etc., etc. (2) The recognition of weights, lengths and sizes. (3) Attention to and retention of names. (4) Discrimination of two complex objects shown successively. In each set of experiments, after training in some one line, the subject was tested for general improvement in the same field. As far as the research has gone, the experiments fail to detect any pronounced influence of special training on general ability except in so far as a person may acquire in a special line of work certain methods and ideals of accuracy and speed which may be of use inther lines.

Professor J. McK. Cattell read a paper 'On relations of time and space in vision.' Experiments were reported showing that a surface moving under a window in a screen appears larger than the window and that if the surface exhibit two colors successively, say green followed by red for $\frac{1}{20}$ sec. each, the observer sees not green followed by red, but the two colors side by side or variously intermingled, the arrangement varying with the observer, but making for perception a spatial continuum. On the other hand, if the line of sight moves over objects, say a row of books on a shelf, each retinal element is successively stimulated but the objects are seen simultaneously, side by side, without fusion, even though the intermittent stimulations be as frequent as 1000 per second.

Thus fusion and indeed all phenomena of color-vision seem to be cerebral rather than retinal.

Professor E. B. Delabarre spoke on 'Conditions affecting the judgment of the direction of lines.' In the judgment of the vertical, besides the factors usually recognized, the following are of especial importance: (1) Attention—fixation does not usually coincide with eye fixation; the latter wanders much though unconsciously, and causes supposedly fixated line to appear constantly changing in degree and direction of inclination; (2) muscle-strains in eye and head also influence the apparent inclination. These same influences affect also other judgments of direction as well as of length and distance. Certain conditions as of illumination, etc., produce definite strains and tendencies to fixation of particular kinds which furnish a fundamental explanation for many forms of geometrical optical illusions.

Professor E. C. Sanford reported briefly upon 'Recent studies in the Clark laboratory,' with the following titles: (1) 'The development in school children of the ability to reproduce rhythms'; (2) 'The rhythm of nursery rhymes'; (3) 'The mental properties of the white rat as tested with the maze.' The first and last of these are portions of more extended studies of the general topics of rhythm and comparative psychology, and all are expected to appear in the *American Journal of Psychology* during the coming year.

Professor Joseph Jastrow discussed 'Pending problems at the Wisconsin laboratory,' and demonstrated various pieces of apparatus, many of them connected with the study of problems in visual perception. The Wood pseudoscope and the reflecting stereoscope were exhibited and explained, and a device for simplifying the demonstration of retinal shadows was shown. The demonstration further included a brief account of experiments in progress on the power of distinguishing in a shadowless light between convex forms varying slightly and regularly in degree of convexity. The sorting apparatus (see *Psychological Review*, May, 1898), was exhibited in its perfected and portable form.

Dr. E. W. Scripture demonstrated several devices in use in the laboratory where this meeting was held, and after some informal contributions and discussion the section adjourned.

In the philosophical section papers were read as follows: 'On practical procedure in inference,' by Professor J. G. Hibben; 'Elements of consciousness,' by Professor Mary Whiton Calkins; 'Choice and nature,' by Dr. E. A. Singer, Jr.; 'Methodology and truth,' by Professor J. E. Creighton; 'The spiritual principle in T. H. Green's philosophy,' by Professor E. B. McGilvary; 'The relation between the moral order and the natural order of the universe,' by Dr. David Irons; 'The development of content in moral judgments,' by Miss Ellen Bliss Talbot; 'The relation of ethics to religion,' by Professor W. G. Everett; 'The contents of religious consciousness,' by Dr. J. H. Leuba; 'Causes of scepticism,' by Professor E. H. Sneath.

At the business meeting Professor Joseph Jastrow, of Wisconsin, was elected President for the ensuing year, and Professors Ladd, of Yale, and Bryan, of Indiana, members of the Council; Professors James and Ladd were elected delegates of the Association to the International Psychological Congress to be held in Paris in 1900, and the Council was empowered to call a meeting of the Association in June in connection with the American Association for the Advancement of Science which will meet at that time at Columbia University.

LIVINGSTON FARRAND,
Secretary.

COLUMBIA UNIVERSITY.

MEETINGS AT COLUMBUS, OHIO, AND NEW HAVEN, CONN., OF SECTION H, ANTHROPOLOGY, OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The meeting at Columbus began with the installation of the chairman, Professor Thomas Wilson and the election of a secretary in place of Dr. G. Dorsey, resigned.

The report of the committee for the 'Study of the White Race in America' was presented by Professor Cattell; it was proposed to establish a station for making certain physical and mental measurements at the next meeting of the Association.

In a paper on 'New Anthropometric Methods' Professor Cattell showed some photographs taken with a centimeter netting close to the face; the method was said to be of special value in making permanent records of an indefinitely large number of measurements. Dr. Frank Russell, in a well-illustrated paper told of his measurements on the skeletons of the Labrador Eskimos and New England Indians. Professor W J McGee described the beginnings of mathematics.

The archæological side of anthropology was well represented. Professor G. Frederick Wright claimed that the separation between the Columbia and Trenton deposits was not so great as supposed by many; an account of observations supporting this claim was given in a paper on the 'Correlation of the Glacial Deltas in the Lower Part of the Delaware and Susquehanna Rivers.' Mr. Cresson's finding of a paleolithic implement in a deposit correlated to the Columbia deposit need not be received with incredulity, as "this would not imply an antiquity more than two or three thousand years greater than that which is implied in the genuineness of the Trenton deposit."

Dr. W. A. Phillips gave a richly illustrated paper on the 'Aboriginal Quarries and Shops at Mill Creek, Union County, Illinois.' A paper was read from Dr. Robert Steiner on a 'Prehistoric Settlement, Big Kiokee Creek, Columbia County, Georgia,' with an account of numerous finds. Dr. Charles Slocum brought forward evidence showing the existence of prehistoric man in the Maumee River Basin.

Dr. Steiner also sent a paper on 'Allan Stevenson's Trance.' Professor McGee read a paper on the 'Cherokee River Cult,' by James Mooney. An account of 'Instruction in Anthropology in Europe and America,' was given by Dr. G. G. MacCurdy. Charles K. Wead gave an account of the 'Natural Diatomic Scale.'

The psychological side of anthropology was represented in the report and paper by Professor Cattell above referred to.

A paper, illustrated by lantern diagrams, was given on the results of 'Researches in Experimental Phonetics,' wherein the curves of the sound-waves in certain vowels and diphthongs had been carefully measured. 'The Inadequacy of the Present Tests for Color-blindness' pointed out the fact that the wool-test, in spite of its universal use in American railways, was not adequate to eliminate color-blind persons from posts where that defect is dangerous; a new color-sense tester was exhibited. In a paper on 'Observations on After-images and Cerebral Light,' several new observations were given as to the results of displacing the eyeballs in the effect of retinal (cerebral) after-images, Purkinje's figures and the image of the yellow spot. In observations on the 'Economy of Sleep' various methods of lengthening sleep were discussed. These four papers were by Dr. E. W. Scripture.

The Columbus meeting was a pleasant and successful one. Over 300 persons were registered for the general Association. The attendance in Section H ran as high as a hundred. The plan was used of connecting all the sections by a telephone system, and of having in each room a blackboard with the titles of the papers being read in all the other sections ; a person attending one section would remain until the announcement of the occurrence of some paper which he wished to hear in another section. The excursions to the gas fields, the coal mines of Hocking Valley, to Ft. Ancient, etc., were specially interesting features provided with a generosity truly Ohioan. The success of the meeting was largely due to the activity of the local committee and its chairman, Professor Thomas.

Professor Amos W. Butler, of Indianapolis, was elected to be Chairman, and Dr. Frank Russell, of Cambridge, Mass., to be Secretary of Section H, at the next general meeting of the Association. This meeting will occur during the third week in June, 1900, in New York City. Dr. Russell kindly performed part of the duties of Secretary at the Christmas meeting.

The special winter meeting of this Section was held in New Haven, Conn., on December 27th to 29th.

At the opening of the meeting Professor Wilson spoke on the need of introducing the Bertillon system uniformly into the measurements of criminals, conscripts, etc., and avoiding the present confusion of two systems and no system. Professor J. McKeen Cattell spoke of the projected station for measuring the members of the American Association for the Advancement of Science, at the next meeting in New York. Dr. J. W. Seaver's account of the result of the measurements of the women in the Freshmen classes in the three colleges at Wellesley, Oberlin, and the University of Nebraska, created considerable comment.

Professor Joseph Jastrow's paper on the anthropology of the occult, suggested the fundamental factor of thought involved in the vagaries of mind of the astrologers, alchemists, mesmerists, faith-cures, and similar folk.

'The art of the Thompson Indians' was described and illustrated with blackboard sketches by Professor Franz Boas. The graphic art of this tribe differs widely from that of the natives along the coast: they employ simple motives, each of which has a symbolic meaning ; in some cases decorating extensive surfaces by repetition of the elements of the design. The following paper by R. B. Dixon upon 'Some basketry designs of the Maidu Indians of California,' gave an account of an art perhaps somewhat more advanced but illustrating the same principles of conventionalism and repetition. A paper upon a kindred topic, 'Symbolism of the Arapaho Indians,' by Dr. A. L. Kroeber closed the morning session.

At the opening of the afternoon meeting, Prof. Franz Boas presented the results of the investigations of Captain G. Comer among 'The Eskimos of Hudson Bay.' The natives of Southampton Island are of special interest to the anthropologist, owing to the fact that they have escaped thus far the contamination that inevitably results from contact with white 'civilization.' They are literally a Stone Age people. The paper upon the 'Archæology of the Thompson River Region,' read by Dr. Harlan Smith, was illustrated by a number of lantern views, showing the talus slopes and other localities where graves were examined, as well as the disposition of their contents, together with various artifacts of the peoples inhabiting the region prior to the arrival of the whites. John R. Swanton, in a paper upon the 'Morphology of the Chinook verb,' stated that the Chinook language exhibited many characteristics peculiar to itself that differentiated it from other American languages. Ales Hrdlička presented the results of his 'Observations on the Ute Indians,' which included an account of their arts and customs, and especially of their physical structure. He regards them as inferior in every way to the adjoining Navajos; considerable uniformity of physical type prevails throughout the various bands composing the tribe. Dr. George T. Stevens exhibited a number of pieces of apparatus for testing the vision, and spoke of 'The pose of the body as related to the type of the cranium and the directions of the planes of vision.' Dr. Stevens also exhibited a number of lantern views illustrating the abnormal poise of the head that results from the adoption of an incorrect plane of vision, which he believed to be in some measure due to the shape of the eye socket, represented in craniometry by the orbital index.

An exhibit of stereoscopic and triple-color slides was made by E. W. Scripture, who also took the occasion to give the first public demonstration of his method of producing anæsthesia by an alternating electric current of moderately high frequency and without drugs of any kind.

The morning session of Thursday opened with a paper by Vice-President Wilson, entitled 'Similarity of thought not necessarily evidence of similarity in culture,' in which he dwelt more particularly upon the evidence obtainable among the higher civilizations—the evidence from the more primitive cultures having been presented in his address at Columbus. Dr. Wilson's investigations lead him to the conclusion that striking similarity or identity of thoughts is extremely rare in literature. G. F. Wright exhibited a number of specimens from Ohio, one of which, a 'Flint core with supposed artificial chippings found in the undisturbed gravel of the Tuscarawas Valley, at Massillon, Ohio.' George H. Pepper read a paper entitled 'Mosaic objects from Pueblo Bonito' that described the ceremonial objects inlaid with jet and turquoise, which have been found among the ruins of the Chaco cañon by the expedition organized by Messrs. B. T. B. and F. E. Hyde and under Mr. Pepper's direction.

Dr. D. A. Sargent presented the results of an extended investigation of physical correlations among Harvard students, particularly with reference to the 'Relation of height, weight, and strength to the cephalic index'. The dolichocephalic men were shown to be taller, heavier and stronger than the brachycephalic. In the discussion it was pointed out that this was in a great measure due to the fact that within the group the tendency is always toward dolichocephaly in the taller individuals and, furthermore, that the environment of the descendants of the earlier immigrants of a dolichocephalic stock was much more favorable than that of the other group. Frank Russell presented a preliminary paper upon 'Some cranial anomalies.' His investigations were made upon a series of over sixteen hundred crania of the American race, the percentages of occurrence of the various anomalies were tabulated, and the results presented a statistical form. George G. MacCurdy exhibited a number of 'Iron figurines from Styria' and described the character and distribution of this curious survival of primitive superstition.

The short afternoon session of the Section was devoted to the paper presented jointly by F. W. Putnam and G. F. Wright upon 'A human bone from the Trenton Gravels.' This important discovery must effectually silence many of the opponents to the theory of the antiquity of man in the Delaware Valley. The bone was found on the first of December, 1899; it is a section of a human femur, showing traces of having been artificially worked. It was found in the stratified and undisturbed gravels seven feet below the surface, at the margin of a canal that is being cut through the plateau, at Trenton. Several lantern views of the bone and of the locality from which it came were shown. It was moved that a vote of thanks be tendered the gentlemen, the Duke of Loubat and Dr. F. E. Hyde, who have advanced the funds necessary for the maintenance of the explorations by Mr. Volk, at Trenton.

At the meeting with the Folk-Lore Society on Friday morning, Section H was called to order by Vice-President Wilson for a short session, during which the committee appointed at the Columbus meeting to consider the advisability of advocating the introduction of the science of anthropology into the curricula of the higher institutions of learning, made its report. The report is given below.

After the adjournment of the Folk-Lore Society, the Section again met to hear Dr. E. Solotaroff read a paper upon 'Comparative Psychology.'

The following report of Committee on Introduction of Anthropologic Teaching, W J McGee, Chairman, was presented:

TO THE CHAIRMAN OF THE SECTIONAL COMMITTEE AND MEMBERS OF SECTION H, A. A. A. S.:

Your Committee on the Introduction of Anthropologic Teaching having exchanged views, chiefly through correspondence, beg to submit a preliminary report, defining a policy and outlining a plan for further work which seem to them feasible.

1. Your Committee are strongly of opinion that anthropologic teaching should be introduced in educational institutions of higher grade as rapidly as practicable; and they are strongly of opinion also that the Anthropologic Section of the American Association for the Advancement of Science is the fittest organization of national character to undertake the introduction of such teaching.

2. Your Committee fully appreciate the difficulties in the way of introducing anthropology into established curricula, especially (*a*) the attendant cost to the institutions, (*b*) the lack of definite information concerning the aims and scope of the science. With the view of overcoming these difficulties, the Committee have been led to recommend a plan for acquainting educational institutions with the methods and purpose of anthropology at a minimum cost, with the expectation that the interest thereby developed may lead to adequate provision for the subject in later curricula. The adoption of the plan would involve personal sacrifice on the part of working anthropologists willing to contribute in time and thought, but would seem to give promise of general advancement in the science.

3. Your Committee recommend that anthropologists desirous of promoting anthropologic teaching in America unite in offering to deliver, before high grade universities and colleges in which anthropology is not now taught, lectures outlining the science, explaining its great interest and utility, and setting forth its adaptability for college teaching; such lectures to be, at the outset, gratuitous, save for suitable provision for traveling expenses.

4. Your Committee recommend that, for the purpose of carrying out this plan, they be continued and given power to act and add to their number.

Your Committee suggest that any unexpended balance of the appropriation by the Council of the A. A. A. S. for the incidental expenses of the New Haven meeting of the Section be allotted for the printing of a suitable circular to be issued to educational institutions of higher grade.

E. W. SCRIPTURE,
Secretary.

TWELFTH ANNUAL MEETING OF THE GEOLOGICAL SOCIETY OF AMERICA, WASHINGTON, DEC. 27–30TH.

II.

On reassembling Friday morning the first paper was the following:

STRATIGRAPHY OF THE POTTSVILLE SERIES IN KENTUCKY.

MARIUS R. CAMPBELL, Washington, D. C.

This paper treated of the areal distribution of the conglomerates of the Pottsville series along the western margin of the Appalachian coal field in Kentucky and Tennessee. Three distinct horizons of conglomerates were described which heretofore have been regarded as a single stratum. Attention is called to the unconformity at the base of the series, and the vertical expansion southward was illustrated by numerous sections measured along the margin of the field.

In discussion David White remarked his having mentioned to the Society that the relatively thin cross-section of the carboniferous in this region only represented a part of the thick eastern outcrops. The older eastern Pottsville is lacking. I. C. White remarked the harmony of the results with those attained in Pennsylvania, and that in the late seventies he had realized the complex nature of the Pottsville in Pennsylvania and Ohio. He commented on the thickening to the south. David White also remarked the trough to the south. W. M. Davis asked about the relations of the marine deposits with corresponding fossils, and the fragmental deposits with land plants. J. J. Stevenson remarked the relations of the Devonian and Carboniferous continent to the sea. The Devonian is thin to the south and thick to the north, whereas the Lower Carboniferous is thin on the north and thick to the south.

I. C. White, replying to W. M. Davis, said that the invertebrate fossils were marine and that the sandstones contained lime. M. R. Campbell said that the materials of the sediments are quartz and that they could not have been derived from lower-lying rocks, which are limestones. The quartz probably came from the Carolina mountains and therefore the water-body was large. Bailey Willis suggested that the Pottsville represented a coastal plain, which was successively transferred, worked over and concentrated.

RELATIVE AGES OF THE KANAWHA AND ALLEGHANY SERIES AS INDICATED BY THE FOSSIL PLANTS.

DAVID WHITE, Washington, D. C.

From an examination of the stratigraphic distribution of the fossil plants of the Kanawha Series in southern West Virginia, it appears that only the upper half of the Series contains the common and characteristic elements of the floras of the Alleghany Series of Northwestern Pennsylvania. The lower half carries a flora which seems distinctly older than any of the floras which occur above the lowest coal of the Alleghany Series.

The plants of the lower Kanawha Series are comparable to those of the Lower Coal Measures of the old World, whereas the plants of the Alleghany Series in Pennsylvania are referable to the Middle and Upper Coal Measures of the European basins.

The discussion of the correlation of the coal floras of the two regions was followed by a brief statement of the stratigraphic changes and conditions of deposition in the Virginian region, as indicated by the distribution of the fossil plants.

I. C. White stated that although the floras changed from Pennsylvania to the Kanawha, the coal seams and sandstones could be traced without a break, from hill to hill. He, therefore, maintained the physical identity of the seams, viz., the Upper Freeport and the Stockton; one of the Kittanings and the Peerless gas coal, etc. M. R. Campbell remarked the possible diagonaling of sandstone and shales, and the pinching out of some. J. J. Stevenson corroborated I. C. White's statements to the letter, and insisted that the difference was a botanical and not a stratigraphic one. H. S. Williams supported David White by analogies drawn from the Catskill problem. I. C. White, in reply, again described the continuity of the Upper Freeport with the Stockton. He also stated that the marine forms contradicted the plants; that an abundant marine fauna beneath the Eagle coal corresponded with that of the ferriferous limestone. H. S. Williams and then I. C. White spoke again, but it was evident that there was a deadlock between the paleobotanists and the field geologists. The difference was so pronounced that all the rest of the Society hoped the two Messrs. White would go together over the field from one end to the other and report at a later meeting.

NEWARK FORMATION OF THE POMPERAUG VALLEY, CONNECTICUT.

WILLIAM HERBERT HOBBS, Madison, Wis.

The Newark formation of the Pomperaug Valley rests unconformably upon and is entirely surrounded by Cambrian and pre-Cambrian gneisses. Its sedimentary beds consist mainly of material of other than local derivation, associated with which are sheets of basalt which were once poured out at the surface. Subsequent to their formation the rocks of the area were elevated, tilted to the southeastward at a low angle, and while in this inclined position depressed an amount not less than 2000 feet. This depression of the area was accomplished through an elaborate system of dislocations (gravity faults) involving hundreds of individual fault planes. Of these more than 200 have been mapped.

The fault planes as mapped are quite regularly spaced. The area is thus cut up into blocks of regular shape, and these blocks are in some cases found to be further subdivided by parallel faults of small displacement until the faulting passes ultimately into prismatic jointing. The directions of the fault planes, which have almost a vertical hade, bear N. 54½° E., N. 5½° W., N. 15° E., and N. 34° W., with less common faults in other directions. Wherever large displacements have resulted from faulting, they are found to be distributed over a number of parallel planes, so as to produce a regular step, or *rampart* structure.

The crystalline gneisses and schists surrounding the basin of the Pomperaug Valley have been deformed by faulting in the same manner as the Newark rocks themselves, thus making it clear that the theory of "lateral compression and differential faulting by accommodation of beds within the gneiss formation" cannot explain the faulting of the Newark formation, as has been claimed.

The peculiar block faulting discovered within the area has brought about a number of topographic forms of relief that have not before been recognized. The drainage of the entire area is found to conform to the deformation, so that both major and minor streams run in courses like eaves-gutters—broken lines with sharp elbows, the elements in the course corresponding in directions with the fault directions named above. The stream channels are generally square in cross section, with a level floor of nearly uniform width, similar to that of an artificial canal. The Pomperaug River, which drains the area, is an illustration of reversal of drainage brought about by the 'discovery' of an upfaulted block of gneiss in its bed. This has resulted in producing a new base level with the formation of a lake above it, which in a later stage has been drained by the pushing back of the divide of one of the principal tributaries, so as to capture the headwaters.

The broad terrane hypothesis regarding the extent of the Newark formation receives material support by this investigation, which shows that an irregular block of the Newark has been depressed below the level of the crystalline gneisses, so as to be by them protected from the abrasion of the ice of the glacial period. The system of faulting within the area furnishes many analogies with the cleavage of a crystal, the explanation of which is doubtless to be found in a probably strained condition of the area, due to the removal of support from below just previous to the time when the dislocations occurred.

The paper was illustrated by lantern slides.

It was followed without discussion by the next title, lunch however, intervening.

THE RIVER SYSTEM OF CONNECTICUT.

William Herbert Hobbs, Madison, Wis.

This paper is closely related to the preceding paper. The system of faults there observed was found to have determined the troughs in which flow the streams of the district.

The attempt has now been made to ascertain if the river system of the state indicates, throughout, the existence of similar troughs. A carefully prepared map based upon the recent topographical map of Connecticut by the U. S. Geological Survey, shows that all the master streams, together with their numerous tributaries, flow in troughs which correspond closely in direction with the fault directions of the Pomperaug Valley system, and with two additional closely related directions. The individual troughs can generally be followed into adjacent states, but no attempt has been made to determine their full extent. Some indication of a regularity in the spacing of the parallel troughs is afforded by the map.

The inference from these facts is that the entire area of the state of Connecticut (and presumably a considerably larger area) has been deformed by faulting in much the same manner as that of the Pomperaug Valley.

The paper was illustrated by a map and by lantern slides.

B. K. Emerson remarked the continuation of these faults to the north into Massachusetts. H. B. Kümmel inquired about the fault scarps and whether the cliffs shown in the views were the result of hard and soft beds. The author replied that they were eroded fault scarps. J. F. Kemp remarked the close correspondence of the phenomena in general with others in the Adirondacks and raised the question of the age of the northwest series as shown by the diversion of the Connecticut at Middletown. W. M. Davis discussed the general influence of faults in the early drainage, but thought that they would not be so influential in later time. He also remarked the possible efects of the mantle of Cretaceous strata which may have covered Connecticut. The effect of drift was cited in influencing the course of the rivers. He also felt that the faults were too rectilinear for natural cases. R. D. Salisbury raised the question of the possible connection of the direction of glacial striae with the rivers. Dr. Hobbs replied that there seemed no apparent one. H. W. Turner inquired whether the faults might not be so recent as to have had influence. Dr. Hobbs admitted its probability and cited the reversal of the Pomperaug by a block of gneiss. In general the paper excited the greatest interest, but the feeling seemed to be, that too many and closely related fault systems were carried over the state, and that too great emphasis was not to be placed on the correspondence of the rivers here and there with them.

JURASSIC ROCKS OF S. E. WYOMING.

Wilbur C. Knight, Laramie, Wyo.

This paper reviews the early history of the Jurassic investigations in Wyoming and gave the distribution of both the marine and fresh water beds in that portion lying east of the North Platte river and south of the Fremont and Elkhorn Railroad. Geological sections from several localities were discussed and reference was made to their fossilized remains. The Jurassic were distinguished from the Triassic. The question was raised as to the advisability of retaining the double term Jura-Trias, and its retention was opposed. The age of the fresh water beds was discussed. Some hints were then given as to the grouping of the Rocky Mountain Jurassic beds and the correlation of them with European.

S. F. Emmons remarked the interest of the work and the contrasts afforded by the Wyoming Jurassic with the Colorado beds. H. W. Turner spoke of the desirability of dropping the name Jura-Trias. W. H. Weed mentioned the parallelism with the Yellowstone Park Jurassic. Bailey Willis explained the early use of the term Jura-Trias, as coördinate with carboniferous and cretaceous, and that it would be split up into local names in the inevitable development of field observation.

THE CRETACEOUS AND TERTIARY SECTION BETWEEN CAPE FEAR AND FAYETTEVILLE, N. C.

J. A. HOLMES, Chapel Hill, N. C.

The speaker remarked the importance of the Hatteras uplift, which extends westward through the 'Sand Hill' region. An east and west section was exhibited passing through Wilmington, N. C., and it was shown that there was a great unconformity between the Cretaceous embracing the Eutaw (300′) and Ripley (800′) and the Tertiary. In the Tertiary very important erosion intervals were also shown at the close of the Eocene and Lafayette.

The paper was discussed by W. B. Clark, who remarked the relations of the strata to others to the north and especially the absence of the Potomac bed. N. H. Darton made a comparison between the section of the Wilmington well and the Norfolk well. G. B. Shattuck remarked the great oscillations of the Atlantic coast that were indicated by these sections. He cited thirteen known unconformities in the coastal plain. T. W. Stanton described the relations of the fossils brought up by the well-borings, to others from Florida. J. A. Holmes remarked the location of the hinge line of the oscillations and the plans now maturing for their measurement.

MESOZOIC STRATIGRAPHY OF BLACK HILLS OF SOUTH DAKOTA.

N. H. DARTON, Washington, D. C.

The Black Hills uplift brings to view the entire series of Mesozoic formations underlying the plains. These comprise Laramie, Fox Hills, Pierre, Niobrara, Benton, Dakota, Lower Cretaceous, Jurassic and Triassic formations. A detailed investigation has been made by the author of the beds from Jurassic to Pierre, and a large amount of detailed data obtained. Fossils have been discovered in the Jurassic beds comprising fish in the basal members, as announced last year, the southern extension of the marine fauna in the intermediate series and additional Dinosaur remains in the upper beds. The relation of the Dakota to the Lower Cretaceous formations were set forth, and an account was given of many newly-discovered features in the stratigraphy of the Benton and Niobrara deposits. In the Pierre shales there has been discovered a horizon of calcareous lenses of *Lucina occidentalis* giving rise to tepee buttes somewhat similar to those described by Gilbert in southeastern Colorado. There was exhibited a fragment of fossil fish found in the Triassic Red beds.

The paper was followed immediately by the next title.

TERTIARY SHORE LINES AND DEPOSITS IN THE BLACK HILLS.

N. H. Darton, U. S. Geol. Survey.

It has been found that the 'White River' (Oligocene), lake deposits of western South Dakota extend far up the flanks of the Black Hills to shore lines, which are beautifully exhibited in a portion of the region. The relations of these deposits throw important light on the physiographic development of the uplift at several of its stages.

The paper was beautifully illustrated by lantern slides, but as the hour was late and no discussion ensued.

In the evening the Society attended the reception and session of the Washington Academy of Sciences, at which Messrs. Merriam, Gannett, Gilbert and Dall described its general results. A collation followed, which afforded an admirable and welcome opportunity for social intercourse.

The last session of the meeting was called to order at 9:45 A. M., on Saturday, December 30th, and showed a rather slim attendance owing to the departure of many of the members.

The first paper was presented by G. O. Smith and W. C. Mendenhall, and was on the 'Tertiary Granite of the Northern Cascades, Washington.' This granite, which a later petrographical study may show to be a quartz monzonite or quartz diorite, extends over an area of at least 100 square miles. It is intrusive between the Tertiary sedimentaries, as shown by the numerous dikes penetrating the surrounding rocks. The sedimentary rocks are slates, sandstones and conglomerates, and show interesting contact phenomena. Much of the slate is metamorphosed into hornfels, and there is abundant development of such minerals as garnet, epidote and tourmaline along the contacts.

This intrusive mass is important in its relation to the age of the sedimentaries, and also in its relation to the basaltic flows farther south.

Professor W. M. Davis read the next paper on 'The Basin Deposits of the Rocky Mountain Region.'

The writer questioned the origin of the Tertiary lake beds of the West, and cited examples to prove his theory that many of them are fluviatile in origin. The sorting out and distribution of the sediments comprising the strata in these beds indicated stream deposition, and, therefore, basin deposits, rather than lake deposits, is the proper term for these beds. He classed deposits according to three modes of origin—'lacustrine,' 'fluviatile' and 'wash,' and argued for the fluviatile and occasionally the 'wash' origin of many of the so-called 'Tertiary lake beds' of the Rocky Mountains. His theory was opposed by Messrs. Weed, Emmons, Cross and Russell, all of whom upheld the lacustrine origin of most of these deposits.

Professor A. P. Coleman presented a short paper on 'Heronite and its Related Rocks.'

Professor Coleman exhibited some specimens of this new analcite rock, which occurs as a series of parallel dikes near Heron Bay, Lake Superior. The rock corresponds chemically to nepheline syenite, and he thought perhaps a petrographical study would show the presence of nepheline. The typical rock consists of analcite in which radiating bundles of feldspar and aegirine crystals are imbedded: while a variety occurs with more feldspar in fluidal arrangement, and a second variety where the feldspar is in the form of spheres, sometimes two inches in diameter.

The succeeding paper was by Dr. H. S. Washington on the 'Magnet Cove Laccolith.' Since the excellent work of the late Dr. J. Francis Williams on the Igneous Rocks of Arkansas, much more has become known through the work of Brögger, Lagorio and others about magmatic differentiation, and Dr. Washington's study of the Magnet Cove area leads him to believe that the soda-rich rock species abounding here are simply highly differentiated products of the same continuous flow, and not of three different periods of eruption, as was thought by Dr. Williams. Six analyses were shown which exhibited such a regular variation in the percentages of the various oxides, that the inference was strong towards magmatic differentiation. The central mass is a basic ijolite with low silica 36.51 per cent., and high calcium oxide and the surrounding more or less concentric masses increase their acidity giving, on the outer band a nepheline syenite with silica 53.38 per cent. and large increase in alkalies and low lime. These successive bands show abnormal arrangement.

Plagioclase is absent from the rocks. The abundant garnet is accounted for through the excess of lime, as shown in the analyses.

The time was too short to allow the speaker to dwell much upon the dikes, or upon the reason for calling the mass a laccolite.

The final paper was then presented by August F. Foerste on 'Further Studies on the History of the Cincinnati Anticline.' The theory held by former investigators that the age of this anticline is Lower Silurian and that the Upper Silurian strata were deposited during the gradual subsidence of the central mass, is untenable as shown by measurements of the adjacent strata. According to this theory the upper or last formed deposits would extend farther up the sides of the anticline, whereas careful measurements show that the lowest formations extend the greatest distance up the sides, and Mr. Foerste's theory is that these deposits at one time were continuous across the present anticline and on account of flexure and erosion now occupy the sides, thus indicating an age for the anticline later than the Upper Silurian.

Mr. Campbell agreed with the speaker that there was no evidence of Lower Silurian age for the anticline.

The following papers were then read by title by the President:

RECONNAISSANCE IN SOUTHEASTERN ARIZONA.
E. T. DUMBLE, La Barranca, Mexico.

ON THE AGE AND DISTRIBUTION OF THE SEDIMENTARY ROCKS OF PATAGONIA.
J. B. HATCHER, Princeton, N. J.

CRETACEOUS INVERTEBRATES FROM PATAGONIA COLLECTED BY J. B. HATCHER.
T. W. STANTON, Washington, D. C.

GEOLOGY OF THE WICHITA MOUNTAINS.
H. FOSTER BAIN, Des Moines, Iowa.

VOLCANICS OF THE NEPONSET VALLEY, BOSTON BASIN.
F. BASCOM, Bryn Mawr, Penna.

ENRICHMENT OF MINERAL VEINS BY LATER METALLIC SULPHIDES.
WALTER HARVEY WEED, Washington, D. C.

VEIN FORMATION AT BOULDER HOT SPRINGS, MONTANA.
WALTER HARVEY WEED, Washington, D. C.

GENESIS OF THE LIMONITE ORES OF PENNSYLVANIA.
T. C. HOPKINS, University of Chicago.

CONTACT METAMORPHISM OF A BASIC IGNEOUS ROCK.
U. S. GRANT, Evanston, Ill.

GEOLOGICAL STRUCTURE OF COFFEYVILLE (KANSAS) GAS FIELD.
G. PERRY GRIMSLEY, Topeka, Kan.

SURFACE TEMPERATURE OF THE EARTH.
ALFRED C. LANE, Lansing, Mich.

THE GLACIATION OF MOUNT KTAADN, MAINE.
RALPH S. TARR, Ithaca, N. Y.

POST-GLACIAL TIME IN HURON COUNTY, MICHIGAN.
ALFRED C. LANE, Lansing, Mich.

KEEWATIN OF EASTERN CENTRAL MINNESOTA.
C. W. Hall, Minneapolis, Minn.

KEWEENAWAN OF EASTERN CENTRAL MINNESOTA.
C. W. Hall, Minneapolis, Minn.

GEOLOGY OF QUEBEC CITY AND ITS ENVIRONS.
Henry M. Ami, Ottawa, Canada.

GAS-WELL SECTIONS IN THE UPPER MOHAWK VALLEY AND CENTRAL NEW YORK.
Charles S. Prosser, Columbus, Ohio.

VERTEBRATE FOOTPRINTS IN CARBONIFEROUS ROCKS OF WRENTHAM, MASS.
J. B. Woodworth, Cambridge, Mass.

About seventy fellows were in attendance and the meeting was a large and in every way an enjoyable one. The Fellows resident in Washington spared neither effort nor expense in entertaining the visitors, and the vote of thanks passed at the final session was a very sincere expression of a deeply felt sentiment.

In the above report the notes for the first three days were prepared by J. F. Kemp, those for the last day by A. S. Eakle.

J. F. Kemp.
Columbia University.

A. S. Eakle.
Harvard University.

SCIENTIFIC BOOKS.

Electro-physiology. By W. Biedermann. Professor of Physiology in Jena. Translated by Frances A. Welby. Macmillan & Co. Vol. II., pp. 500.

Miss Welby's translation of the first volume of this well-known work was reviewed some time ago in these columns. It treated of the structure, contraction, and electrical stimulation of muscle, and of the electromotive phenomena of muscle, epithelium and glandular tissue. The second volume, comprising the structure, conductivity, excitability and electrical stimulation of nerve and the electromotive phenomena of nerve, electrical organ and vegetable cells, has now appeared.

When a physiologist of Professor Biedermann's eminence sums up the results of that department of the science which he has so brilliantly illustrated by the labors of a lifetime, and, knowing well how comparatively narrow will be the circle of his readers, lays his contribution at the feet of his fellow-workers, it may seem ungracious to criticise the gift. Yet we are bound to say, if criticism is not to abdicate its function, that praise must be tempered with censure in passing judgment on this book. That it is full of interesting and important observations, it is unnecessary to say. Even if the author had contented himself with an account of his own experiments this could not fail to be the case. But the treatment of the subject is not always so clear as might have been expected from so great a master. Unnecessary difficulties are placed in the way of the reader by the intricacies of a somewhat diffuse and ponderous style. The lack of proportion and perspective is conspicuous. The author, while doubtless himself well able to discriminate between the importance of weighty generalizations and that of petty experimental details, apparently makes little effort to help his reader to do so, and the student sometimes rises from the perusal with the feeling that he cannot see the wood for the trees.

The author naively admits, in the preface to his first volume, that he has not attempted to avoid partisanship in the treatment of certain topics which have given rise to the liveliest discussion and have separated electro-physiologists into warring camps. He has preferred, as he says, to present these thorny problems from the point of view of his master Hering, which happens also to be his own. The candor of this avowal almost disarms criticism. Yet we must say that although in a sketch such an attitude might be entirely excusable and even praiseworthy, it is to be doubted whether in a professedly exhaustive treatise like the present it is well to skate so lightly over the thin ice of controversy. For it is often impossible to thoroughly understand a question without a knowledge of the history of the disputes that have arisen in regard to it.

Like most of his countrymen, the author scarcely does justice to foreign and especially to

English-speaking physiologists. For instance, in speaking of the electrical variation produced when the retina is stimulated by light, the fundamental observations of Holmgren and of Dewar and McKendrick receive scant mention in comparison with the later, though doubtless valuable results of Kühne.

Of certain other sins of omission the candid critic has cause to complain. In a work of nearly 1000 large pages one would expect to find a highly special branch of physiology presented in an exhaustive way. Yet certain parts of the subject, and these not the least important, are barely sketched, while hundreds of pages are occupied with extraneous matter, or at least with matter which has no particular claim to be included. Why, for instance, should the structure of muscle and nerve, which is so much better treated in histological or anatomical works, cover over 60 pages, the discussion of the conductivity and excitability of nerve 60 more, and the alterations in form of the contracting muscle an additional hundred, while the secondary electromotive phenomena of nerve are dismissed in a bare half dozen pages?

Again, more than 50 pages are given up to the anatomy and histology of the electrical fishes, almost exactly as much space as is devoted to their electrical phenomena.

But although it is not free from faults, the book is a notable contribution to physiology, copious in its information, usually balanced in its judgments, and suggestive in the rare cases in which the author permits himself to speculate. The protest against Boruttau's extravagant hypothesis, which so completely identifies the negative variation with a physical katelectrotonus propagated in the form of a wave, seems to us entirely justified, and the arguments by which the protest is supported particularly cogent.

The translation is upon the whole well done, and better, we think, in the second volume than the first. Of course, as in all translations, there are a few cumbrous renderings which might be improved, and as in most, a few places where the meaning of the author is not expressed or is actually perverted. Occasionally a plural is inaccurately rendered by a singular. Not infrequently the otherwise commendable love of terseness on the part of the translator has led to the omission of qualifying words which it would have been better to translate. As a rule, however, the Anglo-Saxon pruning-knife has been advantageously employed to redress the diffuseness of Teutonic style. The division of the chapters by secondary headings, scarcely attempted in the original, is a great improvement. But it is to be regretted that the weightiest conclusions, expressed in German in spaced type, should not have been similarly indicated in the translation.

In a new edition, which we hope may soon be called for, such errors as the following ought not to remain uncorrected: 'Sewing needle' *for* 'Stricknadel' (p. 37); 'become paler in color' *for* 'einen blasseren Farbenton annehmen' (p. 37); 'inequalities' *for* 'Unvollständigkeit' (p. 38); '*near* the constrictions' *for* '*nebst* den Schnürringen' (p. 42); 'the *middle* part of the nerve rests upon the electrodes' *for* 'auf genau gleichen Elektroden ruht die *centrale* Nervenstrecke' (p. 62); 'itself' *for* 'daher' (p. 69); 'the strength of the peripheral stimulus is *the most* important factor in the diffusion of irradiation' *for* 'ist die Stärke des peripheren Reizes von *wesentlichem* Einfluss, etc.' (p. 70); 'the organ of reflexes, the automatic central structure of the brain and spinal cord' *for* 'die reflexübertragenden *und* automatischen Centralapparate, etc.,' (p. 78); 'built up' *for* 'geschlossen' (p. 87); 'exactly measurable' *for* 'genau abstufbaren' (p. 89); 'similarity' *for* 'Verschiedenheit' (p. 110) (doubtless a slip); 'differences of chemical *reaction*' for 'Verschiedenheit des Chemismus' (p. 111); 'the capacity of reaction, or alteration' *for* 'die Reactionsfähigkeit, beziehungsweise Veränderungen *derselben*' (p. 111); 'when the action of curara has *quite* worn off' *for* 'wenn die volle Wirkung des Curare * * * nachliess' (p. 112). On page 199 we read: "Against the cogency of these experiments there is good evidence to indicate that the electrical taste depends not upon electrolysis of the fluids in the mouth, but upon direct excitation of the taste-nerves." This is the direct opposite of the statement in the original. On page 109 curiosity is awakened by the mention of induction currents "applied directly to a fresh section on the ventral surface of the frog's spinal cord," but it is set at rest when we learn from the original that they were applied on the ventral surface of the spinal cord in the immediate neighborhood of a fresh cross-section. Again, some astonishment is caused by finding (on p. 51) that "one important fact that has hitherto been *overlooked* is the marked variation in calibre of medullated nerve-fibers." We ask ourselves whether it is possible that Biedermann did not know of the long series of investigations on this subject, beginning with those of Bidder and Volkmann half a century ago, and continued in our own day by Gaskell and his pupils and numerous other workers? On turning to the original, however, we find that Biedermann's innocent statement is that this important fact has not yet been '*mentioned*' (erwähnt) in his description. Similarly the at first sight somewhat mystifying contention of Grützner and Tigerstedt (p. 311) "that certain forms, perhaps, indeed, all opening twitches, produced by negative polarization currents are really closing twitches," becomes perfectly rational as a contention "dass gewisse Formen, ja vielleicht alle Oeffnungszuckungen durch den negativen Polarizationsstrom verursachte Schliessungszuckungen sind," which, being interpreted, means "that certain forms, indeed perhaps all opening twitches, are closing twitches produced by the negative polarization currents."

G. N. I. S.

Text-book of the Embryology of the Invertebrates. By Dr. E. Korschelt and Dr. K. Heider. Translated from the German by Matilda Bernard, revised and edited with additional notes by Martin F. Woodward. Vols. II. and III. London, Swan, Sonnenschein & Co.; New York, The Macmillan Co. 1899.

The admirable text-book of Invertebrate Embryology by Drs. Korschelt and Heider is scarcely in need of recommendation at this late day. If embryologists owe a debt of gratitude to Professor Mark and Dr. Woodworth for the translation of the first volume of the work, their obligations are even greater to those who have undertaken the more arduous task of translating the three remaining volumes. The two volumes just published contain the development of the Phoronidea, Bryoza, Brachiopoda, Crustacea and Insecta. Those volumes have been made of equal size by an adroit transposition of some of the chapters of the original text. One notes with pleasure the abolition of the oft recurring word 'fundamental' which the translators of the first volume used in the place of the German word 'Anlage.' As some embryologists have of late been much distressed about the proper translation of this term, it may be well to repeat Mr. Woodward's eminently sensible remarks on the subject. He says: "Exception, with which I concur, has already been taken to the use of this term [fundament], on the ground that the word fundament implies the solid basis or foundation upon which a structure rests or is built, where as an 'Anlage' is essentially a changing, growing structure, which, though at one time the foundation, when only the foundation exists, eventually gives rise to, or rather itself becomes transformed into, the fully formed organ.

"Having thus decided against the continued use of this term, I found myself face to face with the responsibility of selecting one of the numerous terms which have at one time and another been put forward as the English equivalent of 'Anlage,' at the same time time knowing full well that, whichever word was adopted, I should find a large number of biologists against me, as nearly every teacher of note has proposed at least one word which he believes to be the only correct rendering of 'Anlage.'

"Realizing, then, the impossibility of satisfying everyone, I thought it advisable to pass over all the numerous terms which have been recently suggested, none of which are really satisfactory, and to revert to that much abused word—rudiment. Most biologists will agree that the term rudiment, if it had not been misused by some of our most eminent zoologists, would undoubtedly be the best word by which we could render the German term 'Anlage.' Unfortunately, following the lead of Darwin and others, we have acquired the habit of applying the terms rudiment and rudimentary to certain structures present in the adult, which, in consequence of their small size and frequent loss of function, have retained a somewhat embryonic stamp, thus preserving the outward appearance of a rudiment, but losing its essential character, viz., its inherent tendency to further growth. These, then, are not rudiments, but arrested, reduced, vanishing, or vestigial structures, and should be spoken of as vestiges. Why, because Darwin unfortunately misapplied the word rudimentary, should we necessarily regard this misuse as hallowed, and ever after refuse to use the word in its common sense? To such an extent has this misuse of the word been carried that even encyclopædic dictionaries, after defining the word rudiment in such a manner as to prove that it is the very word we are seeking, as a rendering of the idea expressed by 'Anlage,' give us, under the technical use of the word, "In zoology, a part or organ, the development of which has been arrested (see Vestige)." It would require but little trouble on the part of teachers of biology to reinvest the word rudiment with its proper meaning. By carefully insisting on the use of the words vestigium and vestigial or their equivalents, for all abortive or reduced structures met with in the adult animal, and restricting the terms rudiment and rudimentary to all growing and developing tissues and organs, they could insure this result in a few years."

Ample compensation for the long delay necessitated by the change of translators and the size of the work is furnished in the additional matter in the form of foot-notes and bibliography, an addition without which a work on such a rapidly growing subject as invertebrate embryology would by this time be somewhat antiquated. Many of these foot-notes are valuable and suggestive, but others show a lack of perspective, pardonable, perhaps, in translators who cannot be expected to be familiar with all the bearings of the special matter they are rendering into English. An example of this kind is furnished by the undue importance attributed to Willey's paper on *Peripatus novæ-brittaniæ*. Important this paper undoubtedly is as a description of facts, but one may doubt whether Willey's speculations to the effect that *Peripatus* was originally a viviparous form and that species like *P. oviparus* are secondarily modified in their breeding habits, would have been given so much weight by the critical German authors as to lead them to alter their statement (p. 212) that "although the eggs of some species of *Peripatus* have little, or even no yolk, it is highly probable that they are to be traced back to eggs rich in yolk, like those of *P. novæ-zealandiæ*." Willey unfortunately involved the insect embryo in his speculations and here, too, the translators, without a vestige of critical caution, enthusiastically refer the student to the various homologies of the 'trophoblast.'

Such matters are of little importance, however, and are readily overlooked in the perusal of the flexible English rendering of the admirably lucid German text. The book is an invaluable addition to the collection of handbooks required in every zoological laboratory both in this country and in England.

WILLIAM MORTON WHEELER.

Bulletin of the United States Fish Commission, Vol. XVIII., 1898. By GEORGE M. BOWERS, Commissioner. Washington, Government Printing Office. Pp. 576. Plates 128.

The bound volume of the *Bulletin* for 1898 is the largest, and at the same time one of the most interesting, of the series of eighteen numbers which have appeared since 1881. In a prefatory note, Commissioner Bowers dwells upon the importance of the scientific work that has been carried on by those enjoying the privileges of the biological laboratory at Woods Hole, and his statement that "by affording facilities to those persons who may profit by the use of the material available at its various stations, the Commission not only aids in the general progress of science, but extends its own field of usefulness" will be heartily endorsed both by the many who have already profited by the liberality of the Commission, and by men of science generally.

The first article, beautifully illustrated, is by Commander Moser, now with Mr. Agassiz in the Pacific, and is a report on the operations of the *Albatross* during the summer, autumn, and early winter of 1897. It is a history of the 'Salmon and Salmon Fisheries of Alaska,' told in a straightforward way, and contains historical, geographical and biological data of present interest and of permanent value. Inasmuch as the output of salmon for a single year, 1897, was about 43,600,000 cans, one does not wonder that the streams of Alaska are becoming depleted. This depletion, already serious, is caused, not by over-fishing alone, but by 'barricading,' a process whereby the fish are actually prevented from ascending the streams to spawn, and are compelled to remain practically impounded in the lower waters, awaiting the pleasure of the packers. Although barricading is punishable by heavy fine and imprisonment, the laws are not enforced, and an industry now yielding $3,000,000 annually is threatened with ultimate extinction.

Dr. Hugh M. Smith, in charge of the scientific work of the Commission, and Mr. Barton A. Bean contribute a paper on 'The Fishes of the District of Columbia.' This and similar faunistic papers that the authors have published elsewhere have proved of great convenience to ichthyologists and local naturalists, and will be of no little assistance to students of geographical distribution. A second paper by Dr. Smith is on 'The Southern Spring Mackerel Fishery of the United States.' The paper gives an account of the history and importance of this fishery. It reviews the reasons for the prohibition of the fishery by Congress, in 1888; it gives an account of the fishery subsequent to the five years of closure, that is, since 1892; and considers certain questions that are suggested by the facts connected with this remarkable, and in many ways exceptional, action of Congress. It is to be regretted that the spring mackerel fishery, since the termination of the closed period, shows no improvement; the catches of the last seven seasons have not paid for the expense of equipping the vessels.

The article on 'The Mussel Fishery and Pearl-Button Industry of the Mississippi River,' by Dr. Smith, contains a description of the mussels used in button-making; a history of the mussel fishery, which has developed into an important industry during the present decade, nearly four thousand tons of shells having been collected by the fishermen of the Mississippi River in 1898; and a statistical review of the button industry, since the time of its establishment in Muscatine, Iowa, in 1891. The article concludes with certain timely recommendations, which, if early adopted by the States concerned, will prevent the destruction of the industry, now threatened by improvidence and avarice.

The eighth article, by Professor C. J. Herrick, is on the 'Peripheral Nervous System of the Bony Fishes.' It is based upon a study of the silverside, and emanates from the biological laboratory of Woods Hole. Since this paper was issued in the form of a reprint, Professor Herrick's magnificent monograph has appeared in the *Journal of Comparative Neurology*.

Another contribution from the government laboratory is made by Dr. Smith, in his 'Notice of a Filefish new to the Fauna of the United States.' A second capture of this filefish (*Alutera monoceros*) was reported in a recent number of SCIENCE. A third contribution from the laboratory is by the reviewer, and is a brief history of the discovery, disappearance, and final reappearance of the tilefish.

The concluding article is by Charles H. Stevenson, on the 'Preservation of Fishery Products for Food.' It covers more than two hundred pages, is amply illustrated, and is exhaustive in its treatment. The methods of retaining, curing, preserving, storing, packing, and shipping fishery products of the most diverse nature are thoroughly discussed by one who has evidently spared no pains to make his paper of real value.

H. C. BUMPUS.

BOOKS RECEIVED.

Scientific Papers. JOHN WILLIAM STRUTT, BARON RAYLEIGH. Cambridge University Press, 1899. Vol., I., 1869–1881. Pp. xiv + 562. $5.00.

The Kinetic Theory of Gases. OSKAR EMIL MEYER, translated from the second revised edition by ROBERT E. BAYNES. London, New York and Bombay, Longmans, Green & Co. 1899. Pp. xvi + 472.

An Introduction to Physical Chemistry. JAMES WALKER. London and New York, The Macmillan Company. 1899. Pp. x + 335. $2.50.

Outlines of Industrial Chemistry. FRANK HALL THORPE. New York and London, The Macmillan Company. 1899. New and revised edition. Pp. xvii + 541. $3.50.

Minnesota Plant Life. CONWAY MACMILLAN. St. Paul, Minn. 1899. Pp. xxv + 568.

The World and the Individual. JOSIAH ROYCE. Gifford lectures delivered before the University of Aberdeen. New York and London, The Macmillan Company. 1900. Pp. xvi + 588. $3.00.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, December, 1899. On 'Thermal and Dynamic Coefficients,' by J. E. Trevor; 'The Electrolytic Reduction of Potassium Chlorate,' by Adolph L. Voege. This is a quantitative study of the reduction of potassium chlorate under various considerations of density, current strength, poles of different metals, etc. Among the conclusions reached is the greater reduction in acid solutions than in alkaline, and the greater reduction with zinc poles than with those of cadmium or platinum; 'Note on the Preparation of Metallic Lithium,' by Louis Kahlenberg; metalic lithium can be obtained without difficulty by electrolysing a solution of lithium chlorid in pyridin, without the aid of a diaphragm. A carbon anode and iron cathode are used, fourteen volts difference of potential, and 0.2 to 0.3 ampere per 100 sq. cm. of cathode area. The metal is obtained in a dense, well-adhering, silver white coating, possessing all the well-known chemical and physical properties of metallic lithium.

A JOURNAL of Petrology is planned under the auspices of a committee appointed at the last International Congress of Geology. The journal is to have the scope of a Centralblatt, and it is proposed that contributions may be in English, French or German. Professor F. Becke, of the University of Vienna, is Chairman of the committee, and the American members are Professor J. P. Iddings of the University of Chicago, and Professor L. V. Pirsson of Yale University.

SOCIETIES AND ACADEMIES.

WISCONSIN ACADEMY OF SCIENCES, ARTS AND LETTERS.

THE thirtieth annual meeting of the Academy was held at Madison, December 28–30, 1899. The increasing number of meetings of national societies in Christmas week detracts somewhat from the attendance of members at the meetings of the Academy, but all five sessions of the present meeting were very satisfactory. The following list of papers were given and discussed:

'A study of the lead regions of Wisconsin, Illinois, and Iowa,' by Orin G. Libby.

'Household words—their etymology,' by James D. Butler.

'A problem in longevity,' by Charles H. Chandler.

'A new geometrical and analytical solution for determining the principal axes at any point of a rigid body,' by Charles S. Slichter.

'An elementary explanation of the probability curve,' by Charles S. Slichter.

'The ice ramparts formed along the shores of lakes Mendota and Monona during the winter of 1898–99,' by Ernest R. Buckley.

'The principles controlling the deposition of ores,' by Charles R. Van Hise.

'The nepheline syenite of the Wausau district,' by Samuel Weidman.

'Chlorine in natural waters—its accurate determination and significance,' by Erastus G. Smith.

'The action of light on certain nitroso compounds,' by Oswald Schreiner.

'The sour taste of acid salts and their electrolytic dissociation,' by Louis Kahlenberg.

'The historical development of chemical symbols from the times of alchemy to the present' (illustrated by lantern slides), by Oswald Schreiner.

'The absorption of the sun's energy by water,' by Edward A. Birge.

'Some of the undeveloped natural resources of Wisconsin: clays, road materials, and marls,' by Ernest R. Buckley.

'Account of some work done on the State survey,' by Dexter P. Nicholson.

'The work of the Wisconsin Geological and Natural History Survey,' Edward A. Birge.

Two additional papers were read by title: 'The Graphite Deposits of Central Wisconsin,' by G. E. Culver; 'On the Changes of Length of Substances in an Alternating Magnetic Field,' by W. M. Jolliffe.

At the one evening session a dinner was first given by the Madison members to the visiting members followed by a few speeches, including an eloquent plea by Professor Van Hise for the breadth of knowledge which the Academy aims to encourage. The company then adjourned to another room, open to the public, where the retiring President, Professor C. Dwight Marsh, of Ripon College, gave his address: The Plankton of Fresh Water Lakes. It was a well-written general discussion of the minute animal and vegetable life of our lakes, with some reference to economic features, and held the close attention of the audience to the end.

The Academy has now 225 members, and

there were elected at this meeting 18 active and two corresponding members. A new board of officers also were elected, for the term of three years, including Professor C. S. Slichter, University of Wisconsin, President; Professors Harriet B. Merrill, Milwaukee-Downer College, C. H. Chandler, Ripon College, E. G. Smith, Beloit College, Vice-Presidents; Professor F. C. Sharp, Secretary; Professor L. Kahlenberg, Librarian, both of the University of Wisconsin. The library of the Academy will be installed in the fine large building provided for the State Historical Society after the dedication of the building next May.

A. S. FLINT, *Secretary.*

MADISON, WIS., Jan. 1, 1900.

THE KANSAS ACADEMY OF SCIENCE.

THE thirty-second annual meeting of the Kansas Academy of Science was held at McPherson, on December 28–29th. This Academy is a coordinate branch of the State Board of Agriculture, and as such has rooms in the State House, and its Proceedings are printed by the State. The following papers were read at the meeting:

'On Apocynum cannabinum,' by L. E. Sayre.

'The first great roof,' by Charles H. Sternberg.

'Geology of the Glass Mountains of Western Oklahoma,' by Mark White.

'Silica cement mortars,' by William Tweedale.

'The home of the Kansas tiger beetle,' by Warren Knaus.

'An apparatus for determining the relative heating power of coal and gas,' by E. H. S. Bailey.

'Some interesting pyrite crystals,' by J. C. Cooper.

'The Leonid meteors of 1833 as observed by a native Kansan,' by J. R. Mead.

'An example of variation in the human cranium,' by H. J. Harnly.

'Additions to the published flora of Kansas,' by A. S. Hitchcock.

'The testing of paving bricks,' by F. O. Marvin.

'An historical list of Kansas mammals,' by D. E. Lantz.

'Stratigraphy of Eastern Kansas,' by G. I. Adams.

'On some Diatomacæ of Silver Lake and vicinity,' by George H. Curtis.

'Analysis of a magnesium water near Madison,' by F. W. Bushong.

'Collecting notes from Southwest Kansas,' by Warren Knaus.

'Notes on a trip through Western Wyoming,' by J. R. Mead.

'Comparison of the fauna of the Permian of England and America,' by J. W. Beede.

'A geological section of Lyon and Chase counties, along the Cottonwood River,' by Alva J. Smith.

'Harmonic forms,' by B. B. Smyth.

'Ecological areas in Florida flora,' by A. S. Hitchcock.

'Some mineral deposits in Central Missouri,' by S. Z. Sharp.

'The Corona of the sun,' by E. Miller.

Address of the retiring president on 'A theory of the cosmos,' by E. B. Knerr.

E. H. S. B.

WASHINGTON CHEMICAL SOCIETY.

THE regular meeting was held on December 14, 1899.

The first paper of the evening was read by Dr. Bigelow, and was entitled 'The Determination of Metals in Canned Goods,' by W. D. Bigelow and L. S. Munson.

After an examination of a number of the methods most commonly employed, the authors gave preference to a modification of Allen's method.

The entire contents of the can are thoroughly mixed, and 75 to 100 grams taken for analysis. Often it is found preferable to dry the entire sample, extract with petroleum ether, again dry and grind, to obtain a permanent sample. In this case only 25 grams are employed in the determination of metals.

In either case the sample taken is treated with 4 cc. of strong sulfuric acid, 2 cc. of nitric acid and 3 grams of magnesia. The whole is heated on a water bath until it becomes pasty. It is then ignited over a Bunsen burner or in a muffle furnace, until thoroughly charred, ground in a mortar, again ignited to complete combustion, nitric acid being added from time to time towards the close of the operation. The residue is then boiled for a half hour in about 40 cc. of 1–3 hydrochloric acid, almost neutralized with sodium hydroxid, precipitated with hydrogen sulfid and filtered. The precipitate is dried and thoroughly mixed with one gram each of sodium carbonate, potassium carbonate and sulfur, fused for one-half hour in a covered porcelain crucible, digested in water and filtered. The insoluble portion contains copper and lead. It is dissolved in nitric acid, and divided into two equal portions, in one of which the lead is precipitated as chromate and in the other copper is determined by titration with potassium cyanid. The filtrate from the fused sulfids is acidified with acetic acid, filtered and the precipitate thoroughly washed and transferred together with the filter paper to a solution of ferric chlorid, which is heated to the boiling point and titrated with potassium bichromate. Zinc is precipitated as sulfid in the filtrate from the original sulfid precipitate, after adding acetic acid and neutralizing the mineral acid with sodium hydroxid.

The second paper of the evening was read by Dr. Fireman and was entitled: 'The Action of Ammonium Chlorid upon Tetra- and Penta-Chlorides, Preliminary Communication,' by P. Fireman and E. G. Portner.

The last paper of the evening was read by Mr. J. D. Tinsley and was entitled, 'On the Estimation of the Water Soluble Constituents of Soils,' by J. D. Tinsley and F. K. Cameron.

Dr. Seaman spoke on the size of medicine droppers found in the market. He had found them variable, giving drops of different sizes. He showed that the size of the drop depends on the external diameter of the orifice and not on the thickness of the walls.

WM. H. KRUG,
Secretary.

DISCUSSION AND CORRESPONDENCE.

PREVENTION OF HAIL.

BUT little notice has been taken in the United States of the remarkable progress made in northern Italy in the establishment of stations for the protection against injury from hailstorms, by means of the *Wetterschiessen*—one of the old 'superstitions' which has come to honor again in our enlightened age. Shooting and ringing of church bells has for ages been popularly supposed to be efficacious against the effects of thunder-storms, especially of lightning. But the belief found no scientific support, and statistics seemed to prove that the rains supposed to follow the heavy cannonading of great battles are, like the weather changes following those of the moon, quite as much the exception as the rule. Now, however, the matter has taken the practical shape, in the form of stations located at intervals of not more than a kilometer apart in regions subject to hailstorms, and provided with a small cannon placed vertically and surmounted by a six-foot, narrow-conical trumpet, which transmits the vortex and concussion of a 2–3 ounce charge of black powder to the threatening cloud, preventing the formation of hail, and apparently also diminishing the electrical discharges. The idea originated with Burgomeister Moritz Stigel, of Styria, where after three years' experience complete exemption from hail-injury seems to have been secured, so that the inhabitants have abandoned hail insurance, finding the new method cheaper.

In the last semi-annual volume of Proceedings of the Academy of Georgifili, Florence, the subject is once more extensively discussed. A new style of breech-loading rapid-fire gun has been substituted for the original Stigel pattern, and 800 of these anti-hail stations have been and are being established in the region of Brescia, for the protection of vineyards. Small bombs with time fuses have been added to the equipment, and it is stated that the vortex, outlined by means of the dust, reaches the height of two kilometers, and that its low, whistling noise is heard from fourteen to seventeen seconds after the discharge.

E. W. HILGARD.

ELECTRICAL ANÆSTHESIA.

EDITOR OF SCIENCE: My attention has been called to an account in a New York paper of the method of producing anæsthesia by electricity, now being tried experimentally in the Yale Psychological Laboratory. Permit me to say that this account was entirely unauthorized. The demonstration of what had been accomplished was made informally at the recent meeting in New Haven of Section H of the American Association for the Advancement of Science, and no permission was given for any publication of the results. The last authorized statement in regard to the matter appeared in SCIENCE for March 10, 1899; unless there is some reason for the contrary, all future statements will appear first in the columns of SCIENCE.

E. W. SCRIPTURE.

NOTES ON INORGANIC CHEMISTRY.

In a recent number of the *Journal für Gasbeleuchtung* an account by M. van Breukeleveen and A. ter Horst is given, taken from *Het Gas*, of serious trouble from the formation of iron-carbonyl in water-gas mains. This Dutch works manufactures uncarburetted water-gas for use in Welsbach burners, and it is found that in a short time the mantel of the burner loses all its brilliancy owing to the deposition of a brown substance, which micro-chemical analysis proved to be iron. This proved to have been deposited from the iron-carbonyl formed, not in the process of manufacture of water-gas, but in its passage through the cold iron pipes, at ordinary pressure. The only practical remedy seems to be coating the interior of the pipes with tar. A similar deposit is often noticed on the lines used in the Drummond light, where instead of hydrogen, compressed water-gas or even coal gas in steel or wrought iron cylinder is used. Here the only remedy for the diminishing of the light consists in turning the lime quite often.

In the following number of the *Journal* Broockmann takes up the old problem of the gases contained in bituminous coal. At 100° E. von Meyer found a maximum of 238 cubic centimeters gas given off from 100 grams of coal, while Bedson found as high as 818 cc. The great variation in quantity as well as in composition is ascribed, in part at least, by Broockmann to the presence of more or less atmospheric air. He himself worked with a Sprengel vacuum which was kept with repeated warming for three days before the coal was heated, a temperature of 100° then being used. In this way a number of Westfalian coals gave from 7 to 150 cubic centimeters per hundred grams, an English coal 70 cc., a lignite from Habichtswald 50 cc. The gases obtained were generally chiefly methane with more or less carbon dioxid. Higher hydrocarbons, carbon monoxid, and oxygen were rarely present and then only in small quantities. One of the Westfalian coals gave little methane, more carbon dioxid, and over 60 per cent. of nitrogen. Two Oberschlesian coals gave a mixture of carbon dioxid and nitrogen, and the lignite gave 91 per cent. carbon dioxid and nine per cent. carbon monoxid. When heated with air in a closed tube to 160°–200° the oxygen of the air is completely absorbed, leaving only nitrogen with a very little carbon dioxid.

The precipitation of gold by iron pyrites is investigated by P. V. Gladkov in the *Berg- und Hüttenmannische Zeitung*. A solution of gold chlorid is completely precipitated by filtering through a layer of pyrites; if the pyrites carry copper, this and not iron replaces the gold in solution. The reduction takes place in pyrites which have been carefully washed by acid and hence is caused by the sulfid and not by any ferrous sulfate which might have been formed by weathering. The gold is precipitated not as sulfid, but as metallic gold, as is shown by the fact that it can be amalgamated with mercury. This study has considerable bearing on the treatment of pyrite ores of gold.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

THE CHATTANOOGA DISTRICT.

The 'Physiography of the Chattanooga district, in Tennessee, Georgia and Alabama' is elaborately discussed by C. W. Hayes (19 Ann. Rep., U. S. G. S., Pt. II., 1–54, 5 colored maps). The mountains of post-Carboniferous deformation were reduced in Cretaceous time to a broad peneplain (the Cumberland) with scattered or grouped monadnocks; 'unakas' being suggested as a name for grouped residuals. General uplift of the region allowed the development a less extensive peneplain (the Highland-Rim) probably in Eocene time; and a still later uplift permitted the excavation of the present valley floors in Neocene time. The peneplains are referred to subaerial instead of to marine denudation, after a critical review of their origin. Special consideration is given the development and adjustments of the drainage system; the chief streams first flowed westward into an interior sea; then southward along the troughs of Appalachian deformation; then westward again as a result of the shifting of divides by stream action chiefly in the first and second cycles of gradation. It is pointed out that the Tennessee may in the future be once more turned southward by the headward growth of the Coosa. Ridges of hard strata, produced by the dissection of an uplifted peneplain of monoclinal structure, are believed to retain their even crests while reduced toward the new baselevel, and hence should not alone be taken as indicating a peneplain. Differences of structure are recognized as controlling many local drainage adjustments, but broader modifications of drainage are believed to result from "the slight warping of the land service which appears to accompany all uplifts."

RIVER SPACING AND REGIONAL BEVELING.

A WELCOME continuation of the discussion on peneplanation begun by Tarr (*Amer. Geol.*, June, 1898) is found in articles by Shaler (Spacing of rivers with reference to hypothesis of baseleveling. *Bull. Geol. Soc. Amer.*, X., 1899, 263–276) and Tangier Smith (Some aspects of erosion in relation to the theory of the peneplain, *Univ. Cal.*; *Bull. Dept. Geol.*, II., 1899 155–178). The first article suggests that the often observed approach to uniformity of interval between adjacent valleys, and to uniformity in the slope of valley sides "tends to bring about a likeness in the height of the divides even where the original surface was of varied elevation"; and the so-called peneplains of the Appalachian region (such as those of the Chattanooga district, referred to above) are thought to be better accounted for in this way than by baseleveling; but the best preserved peneplain of this region, that of the Piedmont belt, is regarded as beyond explanation by river and atmospheric action, and is therefore by implication referred to a marine origin.

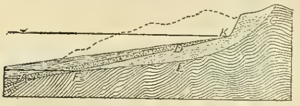
The second article deals more elaborately with the development of graded valley sides and with the correlations of summit height, side slope, and stream action in regions of mature dissection. The roughly equal spacing of the principal rivers of a topographic unit is said to 'follow as a necessary corollary' from the general principles thus deduced. Regions exhibiting a general uniformity of summit height, but so maturely dissected as no longer to preserve remnants of their initial uplands, are regarded as more probably explained by stream spacing and hill grading in the present cycle, than by peneplanation in a former cycle. The beveling of a region by the more rapid degradation of the hills near the coast than in the interior, as previously suggested by Tarr and here more fully stated, is held to give sufficient explanation of facts that have been referred by others to the unequal uplift or tilting of a peneplain. On the other hand, uplands that consist of truncated hills of accordant height, capped with residual soils and bearing old river gravels, are regarded as true uplifted peneplains.

As to beveling *versus* tilting, truly the degradation of hills must be a little faster near the coast than in the interior, but the excess does not account for the slanting descent of the New England upland southward to the shore of Long Island sound, or for the gradual decrease in height of the Cumberland penelain from Tennessee into Alabama.

AN ANCIENT PLAIN IN COLORADO.

W. O. CROSBY gives a detailed account of the remarkably smooth floor of crystalline rocks on which the Cambrian sandstones rest in the Rocky Mountain front range in Colorado. Although now tilted and more or less deformed, the floor is described as originally of very faint relief, with residual eminences only three or four feet high over areas of many square miles; but it may be noted that broad swells and troughs are not excluded by any direct evidence. Comparing this with other smooth sub-Cambrian floors in the United States, Crosby concludes that they are all parts of an extensive surface of planation (abrasion), produced during a period of slow subsidence, by marine attack on a region that "may very well have been reduced to a peneplain by prior subaerial erosion" (*Bull. Geol. Soc. Amer.* X., 1899, 141–164).

The occurrence of marine strata on a floor of firm, unweathered rock certainly points to marine abrasion before deposition began, but it may be urged that the prevailing absence of valleys in the even sub-Cambrian floor suggests the change of 'may very well have been' to 'must have been' in the preceding quotation. The broad floor was in any case the result of the destruction of an extensive pre-Cambrian highland or mountain region, for its rocks are of deformed structure or of deep-seated habit over large areas. During the long period of combined sub-aerial and marine attack upon the highland, large rivers must have cut down deep valleys, while sea waves abraded a plane around its litoral margin ; that is, the valley, *CEF*, would have been eroded, while the marginal plane, *AF*, was abraded. In the time needed to give *AF* a breadth of several miles, the main valley, *EF*, would be reduced to very



gentle slope. Under the supposition that the surface attacked by the encroaching sea was of such a relief that a considerable subsidence might occur during its submergence, the valley, *FE*, would in time be buried by the sediments, *ADK*. No buried valleys are known in the even sub-Cambrian floor. Their absence can be explained only under the supposition that the sea abraded the land to a greater depth than the valleys had been cut in it, and hence that but moderate subsidence occurred during abrasion. Under this limiting condition, extensive peneplanation must have occurred before great marine encroachment by abrasion could have been accomplished.

THE URAL MOUNTAINS.

THE excursion of the International Geological Congress to the Ural Mountains in 1897 gave Dr. F. P. Gulliver opportunity for reaching the following conclusions regarding the evolution of their existing form. A long period of sub-aerial planation, probably aided by marginal marine action, reduced the region to a lowland surmounted by a few monadnocks. The lowland was then arched by successive uplifts, the axes of greatest elevation being east of the middle of the range ; and benched valleys were eroded beneath the general upland level.

Approaching the range from the west, there is a gradual transition from the great Russian planes of nearly horizontal structure to the dissected peneplain of deformed structures. Approaching from the east, a part of the old mountain peneplain remains at moderate altitude adjoining the Siberian Tertiary plains ; unexplained lakes occur in this part of the peneplain, which is generally separated from the revived mountains on the west by an abrupt ascent, thought to be a weathered fault scarp (*Bull. Geol. Soc. Amer.*, X., 1899, 69–82).

W. M. DAVIS.

*NOTES ON TERRESTRIAL MAGNETISM.**

CAPTAIN DENHOLM FRASER, R.E., is at present engaged in making the necessary arrangements for inaugurating a magnetic survey of India and Burma.

CAPTAIN LYONS, R.E., in charge of Geological Survey of Egypt, has for some years been making magnetic observations during his journeys in various parts of Egypt. It is hoped that before long a systematic magnetic survey of Egypt can be undertaken.

TWO proposed sites for the Standard Magnetic Observatory in the vicinity of Washington have been examined during the past month by magnetic parties under Dr. Bauer's direction, in order to determine the most suitable place. One of these sites, situated twenty-two miles to the northwest of Washington, has revealed pronounced magnetic anomalies, while the other site, sixteen miles to the southeast of Washington, has thus far shown no abnormal values. The latter site appears to be also a favorable one as far as freedom from electric tramway influence is concerned.

THERE are at present four observatories at mining stations in Germany, at which the variations of the magnetic declination are being continuously recorded by photographic means, viz.:

1. Clausthal, Harz. This observatory has been in existence since the days of Gauss. It is provided with a Gaussian declinometer for eye-readings, and a more modern instrument for self-registering purposes. Copies of the daily records can be had upon application.
2. Beuthen, Upper Silesia.
3. Bochum, Westphalia.
4. Hermsdorf, bei Waldenburg.

The last three-named stations were started at

* From advanced sheets of *Terrestrial* Magnetism.

the suggestion of Professor Eschanhagen. They publish their declination traces regularly in the interests of the mining engineers.

WHILE residing in Cincinnati, Dr. Baur made magnetic observations about 100 meters west of an electric tramway (double trolley overhead system) running north and south. During the passage of a car, the declination needle was defected 1′—2′.

DR. L. A. BAUER returned to Washington on December 18th, having compared a set of the United States Coast and Geodetic Survey instruments with the standard instruments at the following observatories, viz.: Kew (before and after visiting the succeeding observatories), Potsdam, Pawlousk, and Parc St. Maur. He has also compared his dip circle with three earth-inductors of different construction. At Potsdam (Leonard Weter's inductor), at Pawlousk (Wild's portable inductor), and at Darmstadt (Karl Shering's inductor). The results will be published as soon as the various instruments of the Coast and Geodetic Survey have been intercompared, and when the comparisons at the Toronto Observatory have been made. Owing to the limited time at Dr. Bauer's disposal, it was necessary for him to restrict himself to the above-named observatories.

PROFESSOR E. LEYST, director of the Physico-Geographical Institute of the University of Moscow, includes in his department a systematic course on the theory and practice of measurements in terrestrial magnetism. His students are obliged to determine the magnetic elements, and to set up and operate a set of variation instruments and to determine the constants. The new institute, which will be a model building of its kind, is rapidly approaching completion. Professor Leyst has provided in this building for the installation of a set of variation instruments. The accompanying absolute observations will be made at a point outside of Moscow, far removed from any disturbing influence.

SCIENTIFIC NOTES AND NEWS.

THE CONGRESS OF AMERICAN PHYSICIANS AND SURGEONS.

THE fifth Congress of American Physicians and Surgeons will be held at Washington on May 1st, 2d and 3rd, under the presidency of Professor Henry P. Bowditch. The following fourteen societies join in the triennial Congress:

The American Neurological Association.
The American Gynecological Society.
The American Dermatological Association.
The American Laryngological Association.
The American Surgical Association.
The American Climatological Association.
The Association of American Physicians.
The American Association of Genito-Urinary Surgeons.
The American Orthopedic Association.
The American Physiological Society.
The Association of American Anatomists.
The American Pediatric Society.
The American Ophthalmological Society.
The American Otological Society.

There will be two general sessions of the Congress. The subject at the first of these to be held on Tuesday afternoon, will be 'Bacteriology in Health and Disease,' and papers will be presented by Professor Theobald Smith, Dr. S. J. Meltzer, Professor Harold C. Ernst, Dr. Richard C. Cabot, Dr. Edward R. Baldwin, Professor William S. Thayer, Professor George Dock and Professor Simon Flexner. At the second session, on Wednesday afternoon, the program will be as follows:

'On Modern Therapeutics,' by Prof. William Osler, M.D., LL.D., of Baltimore, Md.

Essay, 'Sociological Status of the Physician,' by Dr. Clarence J. Blake, of Boston, Mass.

Poem 'The Evolution of the Physician,' by Dr. S. Weir Mitchell, M.D., LL.D., of Philadelphia, Pa.

Professor Bowditch will give his address as president on Wednesday evening, the subject being, 'The Medical School of the Future.' This will be followed by a reception and there will be a banquet on Thursday evening. The separate societies will hold their meetings on Tuesday and Wednesday mornings and on Thursday.

The Secretary of the Congress is Dr. W. H. Carmalt, New Haven, Conn.

THE SOCIETY OF AMERICAN BACTERIOLOGISTS.

AT the New Haven meeting of the American Naturalists during the Christmas holidays, a number of the leading bacteriologists of the country met, as previously announced in this Journal, for the purpose of forming a society of bacteriologists. As a result of the meeting there was organized a society which is the first in the country, and probably the first in the world, organized for the distinct purpose of studying and discussing bacteriological problems. The society will in general meet with the American Naturalists. The opening meeting was very auspicious, there being over thirty in attendance. The persons joining in the organization of the society included bacteriologists whose lines of study cover a wide range of subjects. Among them were those devoted to the study of pathology; others studying hygiene. Others again are engaged in the investigation of agricultural topics and yet others interested in the industrial problems of bacteriology. Some papers were also presented upon purely biological aspects of bacteria. The wide range of branches represented indicates the extent to which bacteriology has extended in the short years of its existence as a branch of science, and plainly points out the need of some organization to centralize the work and bring to a common point information of mutual interest.

In addition to the work of organization a program of papers was presented. A more complete account of these papers will appear in a later issue of this Journal.

The society elected the following officers for the coming year:

President, Professor W. T. Sedgwick, Mass. Institute of Technology; *Vice-President*, Professor A. C. Abbott, University of Pennsylvania; *Secretary* and *Treasurer*, Professor H. W. Conn, Wesleyan University; *Council*, Professor Theobald Smith, Professor Harold Ernst, Professor E. O. Jordan and Dr. E. A. de Schweinitz.

Bacteriologists desiring information concerning the society may apply to the secretary, Professor H. W. Conn, Middletown, Connecticut.

WASHINGTON ACADEMY OF SCIENCES.

The by-laws of the Academy were modified in May of last year by providing for a class of non-resident members. A committee representing each branch of science was appointed to consider the elegibility of men of science throughout the country for non-resident membership, and about one hundred members of this class have been elected. It is intended that the Washington Academy of Sciences shall become national in character, in so far as this does not conflict with the field of the National Academy of Sciences, and the American Association for the Advancement of Science. In view of the large number of men of science engaged in the work of the scientific bureaus of the Government and the frequent meetings of scientific societies at Washington, the City has especial claims to be regarded as the chief scientific center of America, and arrangements are contemplated for an annual scientific meeting under the auspices of the Washington Academy, which will be practically a congress of all the scientific men of the country.

At its annual meeting held January 17th, the Academy elected the following officers:

President, Hon. Chas. D. Walcott; *Vice-Presidents*, from the Anthropological Society, W J McGee; from the Biological Society, F. V. Coville; from the Chemical Society, Dr. H. N. Stokes; from the Columbia Historical Society, Hon. John A. Kasson; from the Entomological Society, Dr. Theo. N. Gill; from the Geological Society, G. K. Gilbert; from the Medical Society, Dr. S. C. Busey; from the National Geographic Society, Alexander Graham Bell; from the Philosophical Society, Dr. Geo. M. Sternberg; *Secretary*, Dr. Frank Baker; *Treasurer*, Bernard R. Green; *Managers, Class of 1903*, F. W. Clarke, Dr. C. Hart Merriam, Whitman Cross.

GENERAL.

The Geological Society of Great Britain will this year award its medals and funds as follows: The Wollaston Medal to Dr. G. K. Gilbert, of Washington; the Murchison Medal to Baron A. E. Nordenskiöld, of Stockholm; the Lyell Medal to Dr. J. E. Marr, of Cambridge; the Wollaston Fund to Mr. G. T. Prior; the Murchison Fund to Mr. A. Vaughan Jennings; the Lyell Fund to Miss G. L. Elles; and the Barlow-Jameson Fund to Mr. G. C. Crick and Professor T. T. Groom.

Mr. Percival Lowell of Boston, and Professor D. P. Todd of Amherst College, sailed for Europe on January 17th, and will proceed to North Africa to arrange for observations on the total eclipse of the sun occurring on May 28th. Mr. Lowell's telescope and camera are probably the best instruments hitherto used in such observations. Mr. A. E. Douglass will make simultaneous observations under Mr. Lowell's auspices in Georgia.

PRESIDENT DANIEL C. GILMAN has been granted a year's leave of absence by the trustees of the Johns Hopkins University. He will leave for Europe early in the spring.

PROFESSOR REGINALD A. FESSENDEN, of the electrical engineering department of the Western University of Pennsylvania, has resigned his chair to accept a position in the Signal Department of the United States Weather Bureau, at Washington.

THE Academy of Sciences at Belgium has elected as foreign members, Sir George Stokes, Sir John Murray, M. Moissan, M. Maupas and President Jordan.

THE Royal Astronomical Society of London has elected as foreign members, Professor George E. Hale, of Yerkes Observatory; Professor Robert Helmert, of Berlin University; Professor K. F. Küstner, of the Bonn Observatory; and Dr. Juan M. Thome, of the Argentine National Observatory.

DR. MANUEL ANTON, professor of anthropology at the University of Madrid and secretary of the Museum of Natural Sciences, has been appointed acting director to fill the vacancy caused by the death of Dr. Andres.

IT is gratifying to learn that the manuscript of the new edition of Coues' 'Key to North American Birds,' which has been largely rewritten and rearranged in conformity with the classification and nomenclature of the American Ornithologists' Union, was left by Dr. Coues in a finished condition, and will be published as soon as the new drawings, which are being made by Louis Agassiz Fuertes, are ready.

DR. JAMES MARTINEAU died in London on December 12th, in his ninety-fifth year. He began the study of civil engineering, but soon turned to theology and philosophy, and was appointed professor of philosophy in Manchester New College in 1840. He followed the College to London in 1857, and became its Principal in 1869. Dr. Martineau is well-known for his writings on theology and philosophy, of which one of the most important is 'Types of Ethical Theory,' published in 1885.

DR. WILLIAM A. HAMMOND died at Washington on January 5th. He was at one time Surgeon General of the United States and later Professor of Diseases of the Mind in Bellevue Medical College, New York.

THE *Auk* announces the death of two members of the Ornithologists' Union. Dr. D. Webster Prentiss, one of the founders, but since 1895 a corresponding member, died in Washington on November 19th. He was best known for his contributions to medicine, but published in conjunction with Dr. Coues a list of birds ascertained to inhabit the District of Columbia. Mr. W. W. Colburn, an associate member of the Union died in Springfield on October 17th last. He had been principal of the high schools at Manchester and Springfield, and did much to promote the study of natural history. He had published, in conjunction with Mr. R. O. Morris, a list of 203 species of wild birds observed in Forest Park, Springfield, Mass.

WE regret also to record the death on January 14th of Mr. W. T. Suffolk, treasurer of the Royal Microscopical Society of Great Britain.

MR. ANDREW CARNEGIE has given $50,000 for a library in East Orange, on condition that a site be provided and $5,000 contributed annually for its support. A similar offer has been made to the City of York, Pa., and $40,000 has been offered to the City of Covington, Ky., on the same conditions.

MR. M. L. DELAFIELD, Jr., of New York City, has qualified as the first patron of the Botanical Society of America by giving $250 to the Society.

A BILL has been introduced in the Assembly at Albany appropriating $30,000 to allow the State Engineer and Surveyor to continue to coöperate with the Director of the United States Geological Survey in making a topographic survey and map of the State of New York.

BY direction of the secretary of war, a board of medical officers, to consist of First Lieutenant Jere B. Clayton, assistant surgeon, U. S. A.; First Lieutenant, Richard P. Strong, assistant surgeon, U. S. A., and Acting Assistant Surgeon, Joseph J. Curry, U. S. A., has been appointed to meet at one of the general hospitals in or near Manila, for the purpose of studying tropical diseases in the Philippine Islands.

Dr. E. R. Hodge, pathologist at the United States Army Medical Museum, Washington, D.C., has left for Manila for the purpose of securing for that institution such pathological specimens as may result from active hostilities and the occupation of a tropical country.

We learn from the *Botanical Gazette* that the city of Philadelphia has acquired the dwelling and part of the grounds which belonged to James Logan (1674–1751), with Penn one of the founders of Pennsylvania, and a botanist of note, after whom *Logania*, the type of the Loganiaceæ, was named by Robert Brown. The property will be known as Stenton Park, the original name of the Logan estate, as there is already a Logan Square in the city.

Plans have now been submitted for the new building of the American Geographical Society, New York City, to be erected on West 81st street, opposite the American Museum of Natural History. The estimated cost of the building is $100,000. The façades will be of brick, granite, and terra cotta. An ornamental balcony of carved stone will have a place over the central entrance, with pilasters on either side. Two lamp-posts supporting globes will be put up at the entrance. Beneath the top tier of windows will be blocks of stone with the names of Columbus, Marco Polo, and Magellan. The first floor will contain the lecture hall, while the library will take up the second story.

At the first meeting of the Paris Academy of Medicine for the present year, the prizes to be awarded in 1900, 1901 and 1902 were announced. The prizes for the present year number 36, and vary in value from 300 to 6000 francs. They are, with a few exceptions, open to foreigners, but the manuscripts or printed works must be written in French or Latin. They must be presented not later than February 1st of each year.

The fiftieth anniversary of the foundation of the Paris Society of Biology was celebrated on December 24th. As part of the ceremonies, a commemorative tablet in honor of Claude Bernard, one of the founders of the Society and its second president, was unveiled in his old laboratory in the Collège de France. An address in honor of Bernard was made by M. d'Arsonval, his successor in the chair of medicine. Addresses commemorating the anniversary of the Society were made by the President, Professor Bouchard, and by the General Secretary, M. Gley. M. Leygues, the minister of public instruction, named as officers of the legion of honor, Professor Mathias Duval, M. Gréhaut, the chemist, and M. Capitan, secretary of the Society.

UNIVERSITY AND EDUCATIONAL NEWS.

A memorial has been presented to the Maryland House of Representatives asking for a continuation of the appropriation of $50,000 per annum for the Johns Hopkins University.

President Tucker, speaking before the Dartmouth Alumni Association of Boston, is reported to have said, that during the year six professors, six assistant professors and three instructors had been added to the faculty of Dartmouth College, and that the number of students had been increased by 50. The Wilder physical laboratory completed during the year was said to be the best equipped in New England. Gifts amounting to $150,000 had been received during the year in addition to $300,000 given by Amos Tuck. President Tucker wishes to collect $1,000,000 to celebrate the 100th anniversary of the graduation of Daniel Webster from Dartmouth College.

A committee has been appointed to enquire into the question of establishing a university college for North Staffordshire, England, and report in favor of trying to collect £20,000 for a building.

It is reported that President Ayres of the University of Cincinnati will recommend the discharge of the entire faculty of that institution at the end of the present college year, as a remedy for the troubles that have existed for a long time.

Professor F. A. C. Perrine has resigned from the chair of electrical engineering in Stanford University.

SCIENCE

FRIDAY, FEBRUARY 2, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

ELLIOTT COUES.

ELLIOTT COUES, the eminent ornithologist, died at Johns Hopkins Hospital, Baltimore, Md., December, 25, 1899, at the comparatively early age of 57 years. Dr. Coues was born in Portsmouth, N. H., September 9, 1842. In 1853 his father, Samuel Elliott Coues, removed with his family to Washington, D. C., where Dr. Coues was educated. He was fitted for college at the Jesuit Seminary, now known as Gonzaga College, and in 1857 entered what is now the Columbian University, taking his degree of A. B. in 1861, and his medical degree in 1863, and receiving later from the same institution the honorary degrees of M. A., and Ph.D. While yet a medical student he was enlisted as a medical cadet, and soon after graduation was appointed assistant surgeon in the United States Army, his first station being Fort Whipple, Arizona. Later he was assigned to Fort Macon, North Carolina, and afterwards to Fort McHenry, Baltimore. In 1873 he was ordered to Fort Randall, Dakota, and thence assigned as surgeon and naturalist to the United States Northern Boundary Commission, which surveyed the line of the forty-ninth parallel from the Lake of the Woods westward to the Rocky Mountains. The following six years were spent in Washington, the first two in the preparation of the scientific report of the Northern Boundary Survey, on the conclusion of which he was detailed as secretary and naturalist of the United States Geological and Geographical Survey of the Territories, under the late Dr. F. V. Hayden. In 1880 he was again ordered to Arizona, but the duties of a post-surgeon on the frontier were so incompatible with the prosecution of the scientific work he had then in hand that, failing to receive a more favorable assignment, he resigned his army commission in order to devote his whole attention to scientific pursuits. From 1881 till his death he resided in Washington, making, however, in recent years, several long journeys to the West and Southwest to aid his editorial researches in connection with the early exploration of our trans-Mississippi territory. For ten years, beginning with 1877, he filled the chair of Anatomy at the National Medical College in Washington.

Dr. Coues doubtless inherited from his father, who wrote several notable speculative works on physical science, his strong love for scientific research. His residence in Washington during his early years brought him into close contact with the late Professor Baird, of whom he was a pupil and ardent admirer, and who directed Coues's early ornithological efforts. His very first papers, published while he was still a youth of eighteen, took the form of technical monographs, and would have been creditable to a far more experienced hand. His 'Monograph of the *Tringeæ* of North America' and his 'Monograph of the Genus *Ægiothus*, with Descriptions of New Species,' both appeared in 1861, and in thoroughness of research and in method of presentation foreshadow the author's subsequent eminence in the ornithological field. These were quickly followed by his 'Synopsis of the North American Forms of *Colymbidæ* and *Podicipidæ*' (1862); 'Revision of the Gulls and Terns of North America' (1862); 'Critical Review of the *Procellariidæ*' (1864–1866), and his 'Monograph of the *Alcidæ*' (1868). In the summer of 1860 he made a trip to Labrador, which served as the basis of his notes on the 'Ornithology of Labrador' (1861), and later his residence at various army posts, both in the East and in the West, gave him a wide field experience, which he did not fail to utilize to the utmost.

During the twenty years from 1861 to 1881 he published 300 works and papers, mostly ornithological, and probably as many more between this latter date and the time of his death. Although his ornithological writings relate mainly to North American birds, they also include the science in its broadest sense. He also published a number of special monographs on various families of North American mammals. His contributions to the 'Century Dictionary,' representing about seven years of his best work, include some 40,000 entries which he either edited or contributed, he having editorial charge of the subjects, General Zoology, Biology, and Comparative Anatomy. Another important literary undertaking that absorbed the energies of his later years, also outside of ornithology, was the editing of the original Lewis and Clark 'Journals,' Pike's 'Account' of his journey to the Rocky Mountains, Fowler's 'Journal,' and Larpenteur's 'Personal Narrative.' These works are of the highest interest, relating as they do to the early exploration of western North America, and have been edited and annotated by Coues from the original documents, with a thoroughness and minuteness of detail that adds greatly to their value and interest.

Among Dr. Coues's more important special works may be mentioned the following: 'Key to North American Birds,' 1872, entirely rewritten and republished in 1884; 'Field Ornithology,' 1874; 'Birds of the Northwest,' 1874; 'Fur-bearing Animals,' 1877; 'Monographs of North American

Rodentia' (with J. A. Allen), 1877; 'Birds of the Colorado Valley,' 1878; 'Bibliography of Ornithology,' various installments, 1878–1880; 'New England Bird Life' (with W. A. Stearns), 1882; 'Dictionary and Check-List of North American Birds,' 1882. For four years he edited the publications of the Hayden Survey. Unfortunately only a small portion of his invaluable 'Bibliography of Ornithology' was ever published, but the published part has been of the greatest service to all workers on American birds, to which these portions mainly relate.

No work doubtless has had such a beneficent influence upon the progress of American ornithology as Coues's 'Key,' originally published in 1872, and republished in 1884 as a practically new work. During the last two years it has again been rewritten, and again transformed and brought down to date; we understand the manuscripts were left in such condition that the work will soon go to press, and will doubtless prove a lasting monument to the industry and skill of its gifted author.

Dr. Coues was not lacking in scientific honors. In 1877 he was elected a member of the National Academy of Sciences; he was also a member of all the more prominent American scientific societies, and of many foreign academies and societies. He was one of the founders of the American Ornithologists' Union, at one time its president, and always a member of its council and more important committees. He took a most earnest interest in its welfare and fame, and always viewed with satisfaction and pride his share in its organization and achievements, and his death will be held as a personal loss to his fellow members.

As I have said elsewhere (*Auk*, January, 1900, p. 91), Dr. Coues, as an all-around ornithologist, occupied a position of first-rank among the cultivators of this science. His influence upon the progress of technical ornithology in America is only second to that of Baird; as a popular writer on birds he was without a peer. His rare literary gifts rendered him a fluent and impressive speaker, and a writer of exceptional readability and originality of expression. His activity was prodigious and his capacity for work phenomenal. Though impulsive and at times somewhat erratic, he had many admirable traits, which none can so well appreciate as those who knew him most intimately.

J. A. ALLEN.

THE NEW DEPARTMENT OF VERTEBRATE PALEONTOLOGY OF THE CARNEGIE MUSEUM.

THE organization of this department in the Carnegie Museum during the past year has marked an important advance in the history of this young and growing institution. The unequaled facilities which the western portions of our country afford for the pursuit of this important branch of science have now come to be fully appreciated, and have within the past few years resulted in giving to this study an impetus which a few years ago was totally unknown.

The remarkable consecutiveness of this life record, together with its richness in vertebrate remains, especially in the Mesozoic and the Tertiary rocks, has permitted the gathering of collections of inestimable value when we consider what they contribute to the solution of some of the great problems in biology.

It has always seemed to me that our leading institutions have been unusually slow to recognize the value and importance of these collections, more especially when it is remembered that the greatest development of the science has taken place in this country and has formed such a conspicuous feature of American achievement in scientific investigation. The addition of a new member to the comparatively limited circle, capable of pursuing the subject in a comprehensive way is always a welcome event in science, and the unusually auspicious circumstances under which this, the youngest member of the fraternity, enters the list to compete for honors gives promise of substantial additions to our knowledge in this line of research.

In conformity with the special wishes of the founder of the Institute, Mr. Andrew Carnegie, the department was duly established during the early part of last year. The present force is as yet small, but this will in all probability be augmented from time to time, as occasion requires, and as the necessary space for the proper installation of the collections is secured.

The purpose of the department is the formation of a general collection illustrative of extinct vertebrate life from its earliest appearance up to the present period. This we hope to secure partly by purchase, but largely through expeditions into the various fossil-bearing horizons wherever such can be undertaken with reasonable promise of success.

The first expedition of this kind which was undertaken into the Jurassic formations of Wyoming has recently been completed, and the success attending this preliminary effort has been very gratifying indeed. The party consisted of the writer, in charge, Mr. W. H. Reed and Mr. Arthur Coggeshall, assistants, together with two laborers. A month was spent in the early part of the season prospecting in the vicinity of the 'Freeze Out' Range, on the western part of the great Laramie plain, Wyoming, where comparatively few specimens of interest were obtained. Early in July the Lower Sheep Creek Basin, in the northwestern corner of Albany county, was visited by the party, and a new field of unusual richness was discovered.

That which will prove of the greatest scientific interest and value in the collection, secured in this place, is the larger part of the skeleton of an herbivorous dinosaur, which was at first thought to belong to the genus *Diplodocus.* Of this almost the entire series of presacral vertebræ, the sacrum, and some fourteen or fifteen of the proximal caudals were secured. There are also a complete set of ribs, a scapula, coracoid, and sternum, a complete pelvic girdle lacking one ilium, and one complete femur; all in a most excellent state of preservation. The remainder of the limbs and the skull were not found, but there is much reason to believe that further excavation will bring them to light. No extended search was undertaken in view of the small force and the comparative lateness of the season when the other parts of the skeleton had been made ready for shipment.

This material, at the present writing, is but partially worked out and prepared for study and exhibition; but from the material already prepared it would appear that the genus which it represents is most nearly allied to, if not identical with that described by Professor Marsh from the Black Hills, South Dakota, under the name of *Barosaurus.* If it should transpire that it belongs to *Diplodocus*, which is somewhat doubtful, it will prove very acceptable in that it will supply us with nearly all the missing parts of the skeleton of this interesting group of dinosaurs. Should it, on the other hand, prove to be a species of *Barosaurus*, it will be yet still more interesting, since the genus is known from but a few fragments of caudal vertebræ, at least so far described.

One other specimen, which is certainly that of *Diplodocus*, was secured, in which a few characteristic bones of the skeleton are represented. Other specimens include considerable parts of the skeleton of *Brontosaurus*, among which is an exceptionally perfect hind limb, most beautifully preserved. This will enable us for the first time to fix definitely the organization of the hind foot of this rather abundant group of the Sauropodous dinosaurs. A description of this limb, with some excellent illustrations, will soon be published in the *American Journal of Science.* Still another specimen of great interest, from the underlying marine bed, includes a part of the skeleton with a well preserved skull, of the rare and curious toothless ichthyosaur (*Baptanodon*), originally described by the late Professor Marsh. Besides these, many other specimens were collected, the importance and scientific value of which cannot be fully determined until they are worked out and made ready for study.

The preparation of this material is under the skilful direction of Mr. Arthur Coggeshall, who was for some years connected with the American Museum of Natural History in New York, under the tutorship of that veteran *preparateur*, Mr. Adam Hermann. The material is being rapidly brought into shape for study and exhibition and by the time the new paleontological hall is ready for occupancy, we hope to have a good representation of Jurassic dinosaurs at least.

The department has been exceedingly fortunate of late in securing the services of Mr. O. A. Peterson, late of Princeton University, and previous to that of the American Museum and the U. S. Geological Survey, as chief assistant curator of the department. Mr. Peterson's skill and energy as a collector of vertebrate fossils, as well as his extensive knowledge of the fossil-bearing horizons of our western fields, are well known; he brings to bear a ripe experience (oftimes too lightly valued in the making of a paleontological collection) which cannot fail to be of the greatest advantage to the department in the acquisition of materials.

The work for the coming season will include, besides the continuance of the unfinished exploration in the Jurassic, two other horizons, which will necessitate practically three separate expeditions. From these sources it is hoped to augment the collections very considerably during the present year.

It has been stated recently in the columns of Science that the establishment of this department in the Carnegie Museum was due to the supposed discovery of a dinosaur of extraordinary proportions in Wyoming, in 1898, by Mr. Reed. While it may be true that the newspaper accounts published at the time may have hastened action in the matter, yet I know it to be a fact that ever since the founding of the Institute, Mr. Carnegie has had it in mind to bring together a first-class collection of vertebrate fossils as a part of the Museum exhibit. This is not at all surprising when it is known that he had an intimate personal acquaintance with both Professor Huxley and Professor Marsh, than whom, perhaps, no greater exponents of the subject could have been found, whose opinions and discoveries were calculated to make a more profound impression upon his mind relative to the importance and value of such collections for the general advancement of biological knowledge.

The broad basis upon which he has chosen to establish this undertaking, together with the liberal financial support which he grants to it, are sufficient evidences in themselves if no others could be had, that its inception was not due to a ridiculously exaggerated newspaper account of a bogus discovery, but to a well-conceived plan to carry into execution an important step in the growth of the Institute. It must be assumed that in thus establishing and liberally endowing a department of learning and scientific investigation of such a character, one whose results are destined to enter so deeply into the foundations of our future philosophy, he was not altogether unmindful of the fact that he would be erecting a monument to himself which will endure as long as science is cultivated. Let us hope that these expectations may be realized with the fullest measure of success.

J. L. WORTMAN,
Curator Dept. Vertebrate Pateontology.

AN INTERNATIONAL PLAN FOR THE FUTURE STUDY OF THE VARIATION OF LATITUDE.

UP to the present time the study of the variations of latitude, first observationally proved by Dr. Kustner, of Berlin, and developed by the investigations of Dr. Chandler, has been the result of the work of observers who have been specially interested in this subject.

The stations have not been well distributed for a thorough investigation of the interesting problem, because they have, as a rule, been centered near large observatories dealing with other astronomical matters, when they should be less in clusters, and spread over larger but uniform arcs of longitude.

The International Geodetic Association in the year 1898 formulated a plan which went into operation on January 1, 1900. The aim of the Association has been to put in service four stations, on the same parallel of latitude, and as well distributed around the earth as possible.

The four stations chosen, their latitude and the longitude east or west from Greenwich are as follows:

Mizusawa, Japan,	Lat.	39° 08′ 07″,	141°	E. L.
Carloforte, Italy	"	39° 08′ 12″,	9°	"
Gaithersburg, Md.	"	39° 08′ 10″,	77°	W. L.
Ukiah, Calif.	"	39° 08′ 12″,	123°	"

As one second of arc expresses about 100 feet for differences of distance near the above latitude, it will be seen that all the stations are within the limit of 500 feet of being on the same parallel line.

Professor Porter's observatory at Cincinnati, Ohio, happens to be very near the chosen latitude, and he will also engage in the work, having volunteered to do so.

It is also expected that a station will be established by the Russian government near a city called Tcharjui, and its longitude is 64° east. This observing station is especially important, for it places one between Mizusawa and Carloforte, and 187° from Ukiah.

In the past, many of the astronomers who have given for the use of the student the data necessary for a discussion of the variation of latitude, have made their observations conform to obtaining a correction to the Constant of Aberration from the same material.

The International Association intends that the series of observations which it has just inaugurated shall be made for the distinct purpose of deriving the latitude variation only.

Dr. Albrecht, of the Geodetic Service of Germany, has been greatly interested in formulating the plan of work, and has selected twelve groups, each containing eight pairs of stars. While this is in hand Professor Helmert has advised that each group contain two pairs of large zenith distance, as much as 60°.

Professor Doolittle, at Philadelphia, and Dr. Davis and Professor Rees, of New York, as well as other observers, have noticed in a night's work often an anomalous condition presenting itself in which every pair would clearly indicate an abnormal change of as much as a second of arc from previous and following night's results.

Professor Helmert's idea is to introduce these extra pairs to see if the cause for these marked changes would be more pronounced in those pairs of larger zenith distance.

All the stations are to use the zenith telescope. The instrument has been made by Wanschaff, and has an aperture of a little over four inches, and fifty-one inches focal length.

The method seems to be ideal, because each station will use identically the same reference points in the sky to determine the distance from each to the zenith, and whatever errors of absolute place each star or pair of stars may have, it cannot influence the result, for all use the same stars.

As they will all be reduced from the mean year to date of observation with the same constants, the only error that can in any way influence or mask the small variation of latitude is the proper motion that may obtain to each star, or each pair of stars. If any of the stars have large proper motion, the continued latitude derived from a pair thus affected will be either an increasing or decreasing latitude from that obtained from other pairs.

The completion of this plan in which the stations will be kept in operation, both by the German Geodetic Service, our own Coast Survey and the Russian government, places it upon a plane to sift to the utmost the hidden truths of the problem, and makes possible the determination by a long series of observations, if such is possible, the real value of the terms in the variation of latitude, and if they can be satisfied by any law of prediction as to the future movement of the pole.

GEO. A. HILL.

NAVAL OBSERVATORY,
WASHINGTON, D. C.

THE AMERICAN MORPHOLOGICAL SOCIETY.

THE American Morphological Society held its tenth annual meeting at New Haven, Conn., December 27 and 28, 1899. Among the items of business transacted may be noted the election of Dr. H. L. Bruner, Dr. G. A. Drew, Dr. C. R. Eastman, Dr. C. H. Eigenmann, Dr. J. Y. Graham, Dr. J. B. Johnston, Dr. F. C. Waite and Miss L. B. Wallace to membership in the Society; and the election of the following officers for the year 1900: *President*, T. H. Morgan; *Vice-President*, H. C. Bumpus; *Secretary-Treasurer*, J. S. Kingsley; *Members of Executive Committee*, F. R. Lillie, Jacob Reighard.

The following are abstracts of the papers read before the Society:

The homologies of the ear bones: J. S. KINGSLEY.

The chief points in the paper are the recognition of a distinct skeletal element between hyoid and mandibular arches which in the reptiles forms the extra-columella and in the mammals the manubrial portion of the malleus. In this element was recognized the branchial arch of a segment which has been pointed out in this region from the evidence of somites, neuromeres, cranial nerves, etc. The author maintained the identity of quadrate with incus, articular with the body (caput) of malleus and claimed that no matter what view one took of the homologies of the ossicles of the middle ear, they were forced to admit that the articulation of the lower jaw in the mammals was not homologous with the articulation of the mandible in the lower vertebrates. It was pointed out that the evidence for a reptilian ancestry of the mammals did not stand analysis, and that the origin of the group must be sought in primitive stegocephals.

The foramina of the scapula: J. S. KINGSLEY.

In embryo pigs 18 to 60 mm. long, the dorsal crest of the scapula presents four foramina through which pass dorsal nerves, arising from the second to fifth thoracic ganglia, and passing directly to the skin. These were regarded as possibly indicating that the scapula was made up of metameric parts, and it was pointed out that these results were in full accord with the recent studies of Bolk upon the muscles of the shoulder girdle. They might be interpreted as adverse to Gegenbaur's views as to the origin of the girdles.

On the development and morphology of the actual skeleton of vertebrates: CHARLES S. MINOT.

The author reported observations upon the embryos of man and other mammals, of the chick, and of fishes, which demonstrate the existence of a continuous cartilaginous perichordal rod, for which the term *chondrostyle* is proposed. The chondrostyle is probably the primitive stage, out of which the chondrocranium is developed where there are no myotomes, and out of which vertebral arches, and later vertebral bodies are developed, where the myotomes are persistent.

The arrangement of the mammary glands in litters of unborn pigs: G. H. PARKER and C. BULLARD.

An examination of 1000 litters of unborn pigs showed that the numbers in the litters varied from one to fifteen, the most usual number being six. As there were in all 5970 pigs the average number per litter was 5.97. Of the 5970 pigs examined, 2947 were females and 3023 males, or for every 1000 females there were about 1026 males. In the males the nipples varied from nine to eighteen, the most usual number being twelve and the average 12.434. In the females the nipples varied from eight to eighteen, the most usual number being twelve and the average 11.908. Litters of eight or less would always find ample milk accommodations. Litters larger than eight might be too numerous for the best milk accommodations, and as the number of nipples is not significantly larger in litters of large size than in those of small size, this lack of adjustment must at times be realized.

In abnormal carapace in the sculptured tortoise: G. H. PARKER.

An abnormal carapace of the common sculptured turtle showed at the posterior end of the series of marginal scutes, both right and left, two scutes in place of three, and in the middle of the carapace five bony segments in place of six. The variation in the bony segments is in mesodermic structures and lies anterior to the region of scute variation which is in ectodermic parts. As the ectoderm in tadpoles is known to migrate posteriorly over the mesoderm, it is possible that the same may occur in turtles and that the two regions of variation separated in the adult may have been in an earlier stage at the same transverse plane and induced by the same cause.

The trigemino-facial ganglionic complex of Gadus and Amiurus: C. JUDSON HERRICK.

The details of the composition of this complex as worked out by the author in Menidia, differ in some respects from those given by most other recent students of the cranial nerves of fishes. He accordingly, for purposes of control, worked out microscopically on Weigert sections the composition of the trigemino-facial complex in the codfish very fully and of the cat-fish somewhat less exhaustively. In both of these cases the results of this examination show very clearly that the plan of these nerves, and indeed of the peripheral nervous system as a whole, is fundamentally the same as in Menidia, with only unimportant variations in detail.

In Gadus and Amiurus the trigeminus is as in Menidia, save that the Gasserian ganglion is intra-cranial. In all of these types the facialis has three roots, motor, lateralis and communis, the latter being large in Gadus than in Menidia, and much larger still in Amiurus. In Gadus the geniculate or facial ganglion is crowded close to the Gasserian, yet clearly separable from it. It is intra-cranial and gives rise to the same nerves as in Menidia, except that it contributes nothing to the hyomandibular trunk and does contribute to the r. mandibularis V. The sympathetic system in this region is sharply separable from the cerebro-spinal, and there is no evidence that the facial ganglion is in process of transformation into a sympathetic ganglion. In Amiurus the geniculate is much larger and crowded still more closely up to the Gasserian. It can however be clearly shown that the r. lateralis accessorius in both Gadus and Amiurus is composed mainly of communis fibers and receives no fibers from the Gasserian ganglion.

From these results, and those of Strong, Kingsbury and others, it appears that the peripheral nervous system of Menidia presents us with a paradigm applicable in the broad view to the Ichthyopsida as a whole.

The Teleost gastrula and its modifications: F. B. SUMNER.

The prevailing view that the germ-ring alone furnishes the mesoderm and the entoderm must be revised, as well as the view that in teleosts, the periphery of the plastoderm represents the whole blastopore.

A specialized portion of the blastopore occurs at the posterior end of the embryonic shield a little anterior to the margin. In *Murœna* and probably some other fishes, this takes the form of an open invagination of the 'Deckschicht.' The cell thus invaginated becomes the gut hypoblast. The cavity persists for a while as that of Kupffer's vesicle. Thus Kupffer's original account, written in 1868, was very near the truth, although ignored or rejected by most of his successors.

In the cat-fish, trout and some others this blind sac is replaced by a solid ingrowth, such as Kowalewski described for the goldfish. Kupffer's vesicle is formed in this mass of cells which, in the trout, at least, probably furnishes the whole gut epithelium.

In the case of *Scorpœna* and probably many other pelagic fish eggs, this reduction has still further progressed, and we find at the posterior middle point of the blastoderm a small nodule of cells, causing a thickening of the 'Deckschicht.'

The present writer finds a condition in *Amia* quite comparable to that in *Murœna.* Although the egg of the former is holoblastic, its gastrula is very like that of the Teleosts and far different from that of the Amphibia. Dean has already pointed out in *Amia* the homologue of Kupffer's vesicle. The present writer also finds a rudimentary syncytium or periblast with giant nuclei.

On the embryology and phylogeny of Chimœra: BASHFORD DEAN.

The embryology of a chimæroid throws interesting light on the relations of this doubtful group. By this means the characteristic structures of Holocephali are shown to have arisen from distinctly Selachian conditions: the palato-quadrate in *Chimœra colliei* is thus early separate from the cranium: the frontal clasper is to be regarded as the homologue of a spine of first dorsal fin, which in ontogeny, owing to the precocious growth of the enormous eyes, shifts into its anterior position: the dental plates arise from separate anlagen, which in general are in the adult represented by the tritoral areas.

C. colliei spawns near Monterey, California, throughout the entire year, in deeper water (about 75 fathoms, sp. gr. 1.027, 55° F.). It deposits two eggs almost simultaneously. First cleavage about 26 hours after egg is deposited: early cleavages separated by intervals of from 3 to 6 hours. The young escapes from the egg-case in about 250 days. Polyspermy occurs. Blastula and gastrula distinctly shark-like. Early embryo with broad medullary folds. After closure of folds embryo differentiates as chimæroid. Eye increases enormously in size, altering the shape of the head, and accompanies ventral displacement and obliteration of the spiracle, and the fusion of the palato-quadrate with the cranium. Dermal margin of the hyoidean arch develops early and partly encloses the hinder gill slits. Long external gill-filaments (arising as in shark from the posterior margin of the gill bar) are now present. Tail becomes exceedingly long and attenuated. A highly specialized character is the mode of absorption of yolk material during late embryonic stages. The extra-embryonic blastoderm surrounds a lobe of the yolk: the latter comes to be reduced to independent lobes, and later to a milky fluid which is doubtless appropriated by the embryo by means of its external gills. These now present greatly dilated blood nodes, red in color. The late embryo lies in an opaque nutritive fluid, its relatively small and irregularly shaped yolk sac represents the small lobe early separated from the yolk.

On the occurrence of amphioxus at Bermuda: C. L. Bristol and F. W. Carpenter.

Amphioxus was first found in Bermuda by Professor G. Brown Goode in 1877, but no specimens have ever been studied from the lot then collected. In the season of 1897, the Second New York University Expedition dredged for them unsuccessfully, but in the next season specimens were secured by Professor Verrill in April, and again in June by the Third New York University Expedition at the locality described by Goode at the Flatts Bridge. In addition to this locality, the New York University party found them near Trunk Island in Harrington Sound. Specimens were sent to Professor E. A. Andrews, who reports that they promise to prove *Branchiostoma caribaeum.*

Budding in Cassiopea: R. P. Bigelow.

In the course of an extended study of the development of *Cassiopea xaymacana*, a rhizostomatous medusa obtained in Jamaica, the author found it possible to draw an interesting comparison between the process of budding and strobilization. The buds are formed one at a time on the lower part of the calyx of the scyphistoma. The bud is an evagination of the body wall consisting of three layers—ectoderm, mesoglœa, and endoderm; and in the mesoglœa are embedded four longitudinal muscles which are formed by outgrowths from the adjacent longitudinal muscles of the present.

In the formation of the strobila, the greater part of the scyphistoma is converted into the medusa disc, while the basal polyp is a comparatively small and simple appendage serving mainly for support. This, like the bud, consists of a simple sack with a wall of three layers—ectoderm, mesoglœa and endoderm, and in the mesoglœa there are four longitudinal muscles. Just before the separation of the medusa the basal polyp forms eight tentacles, and a ridge of ectoderm grows out in a circle surrounding the isthmus. When medusa is set free, this ridge enlarges to form a proboscis, more tentacles are developed, and very soon the basal polyp cannot be distinguished from an ordinary scyphistoma developed from a bud.

Before the bud is set free its proximal and distal ends become differentiated structurally, so that it is easy to distinguish them. Soon after becoming free the planula-like bud becomes attached to some solid support by its distal end, and the mouth is formed at the proximal end and becomes surrounded with a crown of tentacles, the orientation is just the opposite of what one would expect and corresponds with what Claus and Goette found to occur in Cotylorhiza.

So the bud and the basal polyp not only correspond in general structure, but in both it is the proximal end that forms the mouth and the distal end the foot. Their orientation is the same, and while attached to the calyx, their central axes meet as an acute angle, the distal ends being directed downward in both cases. Thus there is seen to be a striking analogy, if not homology, between bud and basal polyp. The formation of supernumerary tentacles and other structures is common in this species, so it may be possible to regard the bud as a supernumerary and precociously developed basal polyp.

Notes on the anatomy of Acmœa testudinalis, Müller: M. A. Wilcox.

The following points were made:

1. There is probable, though not conclusive evidence in favor of a winter migration to deeper water.

2. The inner face of the mantle is uniformly clothed with cilia borne, not continuously, but in patches some 20–30 μ apart.

3. Subepidermal glands are situated at the mantle margin. Unlike those described by Haller in a similar position, they are unicellular. Whether they contribute to the formation of the shell is uncertain.

4. The inner face of the mantle also bears subepidermal glands which are scattered and are probably unicellular mucous glands.

5. Animals killed by agents which produce strong contraction, exhibit folds of the mantle which lie parallel to the foot and contain blood spaces. These seem entirely similar to those described by Haller in *Lottia* (*acmœa*) *punctata* but in *A. testudinalis* are artefacts.

6. Both mantle tentacles and those borne on the head are richly provided with sense cells of Flemming.

7. The cephalic tentacles have each a large axial cavity which communicates with the cavity of the head. The wall surrounding the tentacular cavity consists of connective tissue in which longitudinal muscle fibres are imbedded and the tentacle, therefore, is intermediate between the ordinary solid prosobranch tentacle and the invaginable tentacle of the stylommatophora.

8. The chief nephridium closely resembles that of Patella, except that the portion which lies on the left side in *A. testudinalis* extends forward to the pericardium and probably communicates with it. The greater portion of this nephridium corresponds to what Haller describes as part of a coelom.

Locomotion in Solenomya and its relatives. G. A. Drew.

These forms burrow rapidly in mud or sand. The extremity of the foot is provided with two muscular flaps that may lie side by side or be spread apart. When the flaps lie side by side the extremity of the foot is wedge shaped, and the foot can easily be thrust into mud or sand. When the flaps are spread apart they form a very effective anchor. With the foot thrust into the mud and the flaps spread, a contraction of the retractor foot-muscles results in drawing the shell into the mud up to the position of the spread flaps. From this position another thrust can be made.

Beside burrowing, Solenomya swims quite rapidly. The thick elastic cuticle extends past the calcareous portion of the shell, along its ventral borders to a distance fully equal to one-fourth the entire width of the shell. The margins of the mantle have united ventrally, leaving a small posterior opening through which water can be forced, and a larger anterior opening through which the foot can be protruded. The region of the united margins of the mantle is occupied by a rather broad longitudinal muscle that spreads out around the anterior and posterior openings to form sphincters. The radial pallial muscles are also strongly developed. These extend from the calcareous margins of the shell to the free margins of the cuticle.

When the foot is protruded nearly to its full extent, and the pallial muscles are relaxed, the anterior opening is much larger than the foot, and through it water can freely enter the mantle chamber. When the foot is partially retracted and the sphincter muscle around the anterior opening contracts, this channel is entirely obliterated. A strong contraction of both longitudinal and radial pallial muscles, and a further retraction of the foot, fold the mantle and the elastic cuticle into the mantle chamber. At the same time the contraction of the adductor muscles bring the calcareous margins of the shell nearer together, and the mantle chamber is nearly obliterated. As the anterior opening has been closed, the water contained in the mantle chamber is driven through the small posterior opening. Relaxation of the pallial muscles and protrusion of the foot again affords ample opportunity for water to enter the mantle chamber, and the elastic cuticle expands this chamber to its greatest capacity.

By means of the jets thus formed animals frequently swim some feet before settling to the bottom.

Most lamellibranchs possess the power of sending jets of water from the mantle chamber, but they generally depend upon forcibly shutting the shell. Pecten and others swim by means of currents produced in this way, but with most it seems to do little more than free the mantle chamber of dirt. Other forms such as the soft clam, *Mya*, send very strong jets out of their siphons, and depend upon the contraction of muscles in the mantle as well as on closing the shell, to do it.

Until something further is known about the life and feeding habits of Solenomya, we can hardly expect to know the full significance of this mode of expelling water. Very possibly the jets are of value in cleaning the mantle chamber and burrow, and the animal has made use of them secondarily as a means of locomotion.

The ciliary mechanism in the branchial chamber of the pelecypoda: J. L. Kellogg.

The fact is well known that minute particles of matter suspended in water, whether they are to be used as food or not, are, upon coming in contact with the surface of the gills; driven forward and transferred to the inner surfaces of the palps. By these organs they are passed, in the same manner, to the mouth.

It is usually assumed that the animal is able to control this automatic process of filling the digestive tract only by closing the shell and thus preventing the ingress of water bearing suspended matter. There exists, however, a complex mechanism, differing in many respects in different species, by means of which suspended particles may be removed from the body, while water necessary for respiration (especially in active forms such as *Yoldia*) still continues to flow into the branchial chamber.

This mechanism in the common soft clam, *Mya*, may be described briefly as follows:

(1) There is to be found a complete ciliation of the inner surfaces of the mantle folds. Cilia drive foreign bodies from all points of these surfaces to vortices (one on either mantle fold), situated at the side of the opening for the foot in the fused mantle edge, anteriorly. The vortices are within reach of the palps, and food here collected may be taken by them. If the accumulated matter is not desired, the mass eventually falls upon a ciliated tract which carries it posteriorly along the ventral median line of the fused mantle edges, to a bay at the base of the branchial or *incurrent* siphon. From this point it is lost from the body, by the violent contractions of the adductor muscles, resulting in the discharge of the greater part of the water contained in the branchial cavity.

(2) The general ciliation of the surface of the visceral mass causes a movement of particles to a vortex opposite the base of the branchial siphon. Perhaps if desirable, this material upon the surface of the

visceral mass may be transferred to the inner surface of the mantle, referred to above. If not, it is discharged through the branchial siphon on the contraction of the adductor muscles.

(3) Gills, as is well known, collect matter and conduct it forward along a ventral groove to the palps.

(4) The inner surfaces of the palps bear ciliated ridges. In a peculiar manner, the cilia of the ridges drive particles to the mouth. Around the entire margin of the palp is a tract on which the ridges do not extend. Its cilia swiftly carry matter away from the mouth, throwing it off from the posterior, free tips of the palp, into the branchial chamber. Eventually this may be discharged from the body as previously described. By muscular movement these edges may be applied to any surface within reach, sweeping it clean of particles which it may be bearing, and casting the material into the branchial chamber.

In *Yoldia*, which lives in soft mud, the mechanism of the palp, though it performs the same general function, is very much more complex. The plate gills, also, which collect particles with amazing swiftness, may, if desirable, transfer them to the palps, or may be rid of the material by allowing it to pass up through a peculiarly constructed passageway between two plates to the epibranchial chamber, whence it is carried from the body by the stream of water continually being discharged through the epibranchial chamber.

This mechanism is very different in different forms, due to structural peculiarities of regions bearing cilia, and to the habits and needs of various species. We have facts sufficient to show that, without hindrance to the respiratory processes, Pelecypods have the power of collecting food by means of a very complex mechanism; or at will, through the muscular movement of certain ciliated surfaces, of removing any material which it may be desirable to prevent from entering the digestive tract. Data is being collected for a description of this mechanism in as many species as possible.

Observations upon the development of Phascolosoma. J. H. GEROULD.

The forms that were used for investigation were *Phascolosma gouldii*, *Ph. vulgare* (Blainv.) and *Ph. elongatum* (Keferst.) The ova which are ready for maturation are swept into the nephridia by the action of the cilia of nephrostome and of the internal surface of the nephridium. The eggs that are found within the nephridia, prior to their ejection through the nephridiopore, have the spindle of the first polar globule with ten rod-shaped chromosomes already formed. The astrosphere of the male pronucleus precedes the nucleus in the migration of both toward the center of the cytoplasm; it usually divides before the union of the two pronuclei. The segmentation nucleus contains twenty chromatic filaments which split longitudinally.

The alternating directions of the cleavage planes as far as forty-eight cells are identical with those in corresponding stages in the eggs of annelids, most molluscs, etc. The most striking peculiarity in *Phascolosoma* is the large size of the first set of 'micromeres,' which in quadrants A, B and C are distinctly larger than their sister cells at the vegetative pole. The 'macromeres' throughout the course of cleavage are of small size.

The mesoderm is derived from d^4, which in the one instance observed divided in harmony with the regular alternation in direction; its posterior derivative divided immediately to form a second mesoblast. In the divisions of the cells of the somatic plate deviations from the rule of alternation in the direction of cleavage were observed.

The rosette, cross and intermediate cells are established when the egg has only forty-eight cells. The rosette cells are very large; and the ciliated prototroch, which consists of sixteen cells, derived from the first set of 'micromeres,' forms a complete girdle around the egg.

A typical trochophore is formed, of which the plane of bilateral symmetry corresponds to a vertical plane bisecting *B* and *D* of the four-celled stage. A postoral circlet of strong cilia appear at a short interval behind the prototroch, and a long tuft of flagella is still earlier developed upon the apical plate. There is no true paratroch. Eye spots are present, and trochophores and larvæ are positively phototactic.

No traces of metameric segmentation manifest themselves throughout the course of development, which was observed continuously until the young worms had reached the age of seven weeks. This and certain other embryological facts seem to indicate that the *Gephyrea* are somewhat more closely related to the *Platyhelminthes* than to the *Annelida*.

Notes on the structure of Alma nilotica, a gilled earthworm from Egypt: P. M. Rea.

Alma nilotica Grube, has been known since 1855, but has never been thoroughly investigated. Its systematic position is uncertain, but the present research shows conclusively that it is an Oligochaete having many of the characteristics of the Geoscolicidae. The possibility of the identity of this form with the genus *Siphonogaster* of Levinsen increases the interest of this remarkable worm. The material available at present is sexually immature, but it is hoped that specimens collected in the spring will determine this point. A pair of ovaries has been demonstrated in segment 13 and testes in 10 and 11, but no evidence of the enormous penial processes of *Siphonogaster*.

The gills, which are the most characteristic feature of the worm, are out-pocketings of the body wall, taking with them the layer of circular muscles but leaving the longitudinal muscles behind. They are provided with afferent and efferent blood vessels. The epithelium of the gills and whole body surface is highly vascular. The dorsal blood vessel extends no farther forward than the seventh segment, where it ends abruptly in the most anterior pair of hearts. There is a supra-œsophageal vessel and two remarkable lateral vessels which will be more fully discussed in a later paper. Connected with the lateral vessels are numerous spherical acini, closely approximated to the inner surface of the body-wall, which appear to be identical with the structures figured by Perrier as occurring on the walls of the œsophagus in Perichaeta.

On the life history of Autolytus cornutus and alternate generation in annelids: P. C. Mensch.

The claim for alternate generation in annelids arises from investigation on the Syllidians, chiefly *Autolytus*. It was first suggested by Quatrefages and Krohn, but for the first time fully described by A. Agassiz for *Autolytus cornutus*. Agassiz regarded the parent stock as distinctly asexual and in this manner described a true alternate generation—the asexual parent stock alternating with sexual stolons.

The asexual condition of the parent stock is, however, not constant and the percentage of parent stocks with sexual products is sufficiently great to strongly indicate that the presence of reproductive products toward the close of the phenomenon of budding is a constant stage in the life-history of this Syllid. This being the case there would be, not an alternation of generation but at most only a sexual dimorphism.

Another aspect of this question is presented by the morphological characters of the stolon itself, in that the stolon does not attain the value of a distinct individual, as compared with the fission in other annelids (*Dero*, *Aeolosoma*), but the entire process is more like the sexual fragmentation described for the Palolo worm.

Metamerism of the Leech. W. E. CASTLE.

Following Gratiolet, most students of leech metamerism regard the annulus which bears the metameric sense organs as the first (most anterior) annulus of the somite. Careful study shows, however, that the sensory annulus is really the *middle*, not the most anterior ring of the somite.

The true limits of the somite are indicated by the distribution of the metameric nerves, all the annuli of a somite being innervated from one and the same ganglion. This is shown by the following facts:

1. In somite abbreviation rings innervated from the same ganglion fuse together.

2. In somite growth (multiplication of annuli) new rings appear chiefly at the limits of the somite (as defined), usually first at the posterior, then at the anterior end of the somite.

3. An abnormal animal, in which a somite is wanting in either half of the body, shows that the missing rings form a somite, limited as stated above.

The multi-annulate structure of the leech somite is correlated with the restricted number of somites in the body (thirty-four both in the Rhyncobdellidæ and in the Gnathobdellidæ). Increase in length of body and complexity of structure has been brought about not by multiplication of somites, as in the Chætopoda, but by elongation of existing somites and multiplication of their annuli.

Whitman and Bristol have established the derivation of the five-ringed type of somite from the three-ringed type; several facts indicated the probable earlier derivation of both from a one-ringed type of somite. Among these may be mentioned the manner of somite abbreviation and the structure of the somite in Branchiobdella and related forms.

The development of the pigment and color pattern in Coleoptera: W. L. TOWER.

The object of this research was to find out if possible: (I.) the way in which the colored patterns developed, and the sequence of the colors in ontogeny, (II.) the origin of the pigment and its development, (III.) something of its composition.

I. In Coleoptera two types of colorations are found.

(1) Unicolorous, where the whole animal is of one color.

(2) Multicolorous, where there is a color pattern of two or more colors.

I have studied the development of the color pattern in several forms of each type.

After the larva transforms to a pupa it is white or pale yellow. Color first appears on the cuticula of the future beetle about the opening of the spiracles, *i. e.*, where the spiracular muscles are attached to the cuticula. Color next appears upon the prothorax as two bands laterad of the median line, then a more or less broken band laterad of the first two appears, and last of all two spots at the anterior and posterior outer angles. The places where color first appears is over the attachment of the muscles to the cuticula. These spots may all become united as in the unicolorous, or remain separated as in multicolorous type forms. Color next appears upon the head, over the attachment of the cranial muscles to the cuticula, and then color appears upon the ventral abdominal surface over the muscular attachments.

The color as it first appears is pale yellowish brown which rapidly darkens, becomes very dark brown or black. This dark or black color is, according to Hagen, dermal pigment: There are some beetles that have a unicolorous type of color pattern but are yellow or orange in color. Yellow and orange are hypodermic colors according to Hagen. These beetles are few in number. I have not yet been able to get material to study one of these forms.

In all the beetles that I have studied color appears first over the origin or attachment of the body muscles to the cuticula. No color appears upon the wings until they are out of the pupa case and the wings are fully expanded. Then color appears first between the nervules as longitudinal bands which may become confluent, remain as bands or break up into rows of spots.

The pupa becomes first white (*i. e.*, a yellowish white), then yellow or ochre yellow, then the special adult colors develop so that the sequence of development is yellowish white (due to the color of hæmolymph), yellow, ochre yellow, yellow brown, brown, dark brown and black.

II. The pigment forms, first as a waxy transparent layer upon the surface of the cuticula. This waxy layer is excreted from hypodermal gland cells having openings upon the surface. This waxy secretion forms a secondary cuticula which is the pigmental cuticula; the primary (embryonic) cuticula is unpigmented.

After the waxy layer has attained a considerable thickness, it becomes darkened over the places where dark pigment is to develop. This layer is homogeneous without lamellæ or pore canals. Only dark, *i. e.*, black brown or dark red color appears to be formed in this secondary cuticula layer. Yellow is always formed from the precipitation of solids from the hæmolymph in or among the hypodermal cells.

If the hæmolymph is allowed to dry in the air, it becomes yellow brown in color, and when some quantity is allowed to dry it appears very dark or even black by reflected light. If hæmolymph is precipitated by heat, a yellow mass is thrown down, leaving an ochre yellow fluid, which can be decanted off. The yellow precipitate in sealed tubes bleaches on exposure to light. It also darkens on exposure to air. If O_2 be passed through the yellow liquid, it rapidly becomes dark brown, and on concentration by evaporation, leaves a waxy residue.

If the hæmolymph be mixed with .1% $HClHC_2H_3O_2$ or almost any acid, it becomes red, but the yellow color is restored by an alkali as .5% NH_4OH.

III. I have been unable to determine the composition of the pigment, owing to the difficulty of isolating it. I have made some tests upon the hæmolymph and have demonstrated Fe, Na, Mg salts, albumen, fibrin, globulin, xanthophyl to be present.

IV. Summary of results:

(*a*) On the body color (dark) develops first over the attachment of the muscles to the cuticula.

(*b*) The multicolorous type of color pattern is the least specialized; the unicolorous type having dark color is the most specialized, and the unicolorous yellow type is the most primitive of color pattern in Coleoptera.

(*c*) The pigment is situated in a secondary cuticular layer external to the primary cuticula which is unpigmented.

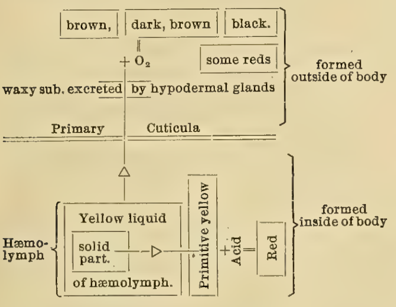
(*d*) The pigment is derived from the hæmolymph of the pupa. The dark pigments, black, brown and some reds are derived from the oxidation of a substance, elaborated from the more liquid part of the hæmolymph by the hypodermal gland cells. Yellow is due to the precipitation of the solid parts of the hæmolymph among the hypodermal cells.

(*e*) Yellow and red are the neutral or alkaline, and the acid modification of the same substance. This substance I believe to be like litmus in its reaction to acid and alkali.

Yellow is the more primitive color, while red is the acid differential of the yellow pigment. Acid may come from acid formed by metabolism (uric acid) or secreted by special cells.

Brown, dark brown and black are due to the oxidation of the yellow waxy pigment.

I may express the relation of these pigments in the following diagram :



Notes on mammalian embryology: CHARLES S. MINOT.

The author exhibited drawings, wood engravings made in Germany, and lantern slides illustrating the development of the pig. The work has been done in connection with the preparation of an 'Introduction to Embryology' for the use of students, intended for practical work. It is proposed to study a few of the most typical stages in a series of carefully selected typical sections, and to connect the descriptions of these sections with explanations of the relations of the embryonic organs to the adult anatomy on the one hand, and to the germ layers on the other. The principal engravings are being made by Probst in Brunswick, the author believing that the German method of wood engraving is better adapted to the representation of sections of embryos than are either the 'process' methods, or the American style of wood engraving.

On the spermatogenesis of Peripatus: THOS. H. MONTGOMERY, JR.

The spermatogenesis of *Peripatus balfouri* Sedg. is interesting, first, because it has essentially the type of that of Insects (as distinct from that of Crustacea as known for the Copepoda), and second, because the character of its cells is very favorable for the determination of the stages which occur in the synapsis stage (an anaphase of the last spermatogonic division). The reduction of the number of chromosomes (from 28 to 14) takes place in the early synapsis by a fusion end to end of every two chromosomes, those ends of the chromosomes joining together which are situated nearest that point of the cell where the centrosomes lie. Each resulting bivalent chromosome has the form of a U or V, whereby the bend or angle of the U or V is the point of union of two univalent chromosomes; this point of union is effected by a band of linin which appears to be a remnant of that continuous linin spirem thread present in the preceding prophase of the spermatogonic division. Later the two arms of each bivalent chromosome become longitudinally split. The chromosomes appear to preserve their separateness (individuality) during the following rest stage. In the first spermatocytic division each bivalent chromosome becomes transversely split (through the linin band joining its two component univalent chromosomes); in the second spermatocytic division each (now univalent) chromosome becomes longitudinally split. This account serves merely as a brief preliminary note to observations which will be soon published *in extenso*.

Palæmonetes and salinity; an experimental study in evolution: ROSWELL H. JOHNSON and ROBERT W. HALL.

A common shrimp on our Atlantic coast, *Palæmonetes vulgaris*, is provided with small spines on the beak or rostrum. These spines vary considerably in number on individual specimens, but the *average* number on specimens from salt water from different localities is quite constant, being about thirteen. When this shrimp is found in *brackish water*, however, the averages from different localities vary considerably, and *are always less* than the salt water average. In water which was nearly fresh, we have found the average to be as low as 9.61. Moreover, the decrease in the average seems to be in proportion to the decrease in density. This seems to show that such a character as rostral spinosity may be so correlated with the economy of the animal, that such a factor as salinity may determine it. The experiment of putting the animals from salt water directly into fresh water failed to show that those whose average number of spines was the least, had the greatest resistance capacity. Hence it is suspected that the direct action of environment, and not natural selection, is the method by which the evolution to the brackish-water form is accomplished. This question can be settled only by *rearing* the salt-water form in fresh or brackish water. The decrease in spinosity of the brackish-water form makes it seem probable that our fresh water species, *P. exilipes*, has been derived from *P. vulgaris*. The two species are very similar and, at least in respect to rostral-spinosity, intergrade perfectly; for the averages in *exilipes* are found to vary from 8.53 to 10.11, while *P. vulgaris*, as shown above, may have as low an average as 9.61. Experimentation may also throw light on the question as to whether *P. exilipes* has arisen as a variety in one place, and later spread, or has originated in different places under a common factor of environment—lessened density. In one case where the two forms were found inhabiting the same river (The St. Johns, Fla.), they were separated by a distance of only thirty miles, at most.

Variations and regeneration and Synapta Inhaereus.

The characters of this holothurian as described in systematic works, were subjected to quantitative analysis. The standard deviation, mean, mode and coefficient of variability were determined for 850 variates of the anchor and anchor-plates, 13 variations from the typical anchor and 20 variations from the typical anchor-plate were described. The typical anchor prevailed in 96.6% of the variates and the plate in 61.5%.

The specimens examined from Beaufort and Naples showed only one type, that of the described anchor and three types of plate with an adherence of $95\frac{3}{4}$% to the typical form. The specimens from southern waters are therefore least variable while the striking divergence is shown in the northern collections from Long Island, and Woods Holl with 18 types of plates, with 8 types of anchors showing spurs of various kinds, there is shown a tendency toward a place-mode at Lloyds Harbor, Long Island.

In one specimen from Centre Island, Cold Spring Harbor, Long Island, 61 3-7% of the variates belong to another than the type-pattern. Similar variations in the number of tentacles with their relation to the normal symmetry were noted. The mode of distribution of digits is three on the dorsal and ventral sides, respectively.

Nine out of 17 experiments on regeneration of the body and tentacles were successful.

The effect of strychnine on the unfertilized eggs of the sea-urchin: T. H. MORGAN.

When the unfertilized eggs of *Arbacia* are placed in sea water containing strychnine they will begin to segment in the course of three or four hours. Strychnine, either as an alkoid or as a sulphate, produces the same effect; the solubility of the latter being nearly a hundred times greater than that of the former. Saturated solutions were used. The eggs divide usually into a larger and a smaller part and the segmentation may continue through several subsequent divisions. The result is the same whether the eggs are left in the solution or whether transferred after two to three hours to sea water.

A certain time is necessary to start these changes in the eggs. Eggs left for one hour in the solution showed little subsequent segmentation, and even after one and a-half hours sojourn in the solution, only a few of the eggs divided after being returned to sea water. Richard Hertwig had shown that if the unfertilized eggs of a sea-urchin are put into sea water containing strychnine, that after a time the nuclear wall breaks down, a nuclear spindle forms around the chromosomes, and after division of the latter, a new nucleus reforms. My own results show that a nearly similar change takes place in *Arbacia*, but the chromosomes of many eggs separate after division and make two (or more) new nuclei. If this happens, a subsequent division of the protoplasm takes place.

The changes brought about by the strychnine have many points of resemblance to those that take place in the unfertilized eggs acted upon by certain salt solutions: magnesium, sodium or potassium chloride. In the latter instances I have tried to show that the transportation of the chromosomes is brought about by the astrospheres that appear in the egg and the number of new cells that form is, in general, in proportion to the number of astrospheres that are present in the egg. The latter being more numerous, produce a wider distribution of the chromosomes.

The absence of these astrospheres in the eggs acted upon by the strychnine accounts for the fewer divisions of the protoplasm in these eggs. All of these substances produce a slight shrinkage of the egg and it seemed not improbable that the cleavage of the egg might be the result of the plasmolysis, especially since the fertilized egg also sets free water or some other fluid at the moment the spermatozoön enters. In order to test this possibility I tried the effect of different strengths of magnesium and sodium chlorides—percentages ranging from those that do not affect the eggs to those that kill the eggs in a few minutes. The results show that isotonic solutions of these two salts produce very different results. The eggs will withstand a solution of magnesium chloride that was twice the strength of sodium chloride. This is the more surprising since the latter salt exists in sea-water in nearly ten times the quantity of the former.

The results also show that it takes a weak solution very much longer to act than a stronger one. The length of time being out of all proportion to the plasmolyzing effect of the solution. Further, a solution so strong that it will kill the eggs in half an hour, will cause the eggs to divide in several parts if they are left in the solution for five minutes and then transferred to sea-water.

In a previous paper I have compared the action of these substances to the action of stimuli on a nerve or a muscle. A large number of very different kinds of stimuli will start a nerve-impulse or a muscular contraction, the result depending more upon the structure of the living part than upon the stimulus employed. The unfertilized egg of the sea-urchin is likewise in a state of unstable equilibrium prepared to undergo a definite series of changes along given lines. These changes can be started in several ways, and resemble more or less perfectly the changes following fertilization, but I believe it would be as erroneous to compare the action of these substances directly with the process of fertilization as it would be to affirm that the action of a sudden blow on a muscle producing contraction is the same as the normal nerve impulse received through the nerve. The result is more or less the same because the same mechanism is set to work in the muscle or in the egg, but it would be misleading to infer that, therefore, the stimuli are themselves alike because they produce nearly similar results.

Reissner's fibre in the canalis centralis of vertebrates. PORTER EDWARD SARGENT.

Reissner in 1860 described in Petromyzon a cylindrical rod or fibre lying in the canalis centralis. His discovery was confirmed three years later by Kutschin who named it Reissner's fibre. Its presence has since been noted in a considerable number of fishes by three other investigators. By these it has been generally considered an artifact formed by the coagulation of the cerebro-spinal fluid.

Researches carried on during the past year has proved it to be a continuous fibre extending through the whole length of the canalis centralis and into the brain ventricles, and constituting an integral part of the central nervous system of *all* vertebrates.

As its posterior end Reissner's fibre gives off fine processes which pass peripherally between the epithelial cells forming the walls of the canal into the nervous substances of the cord. Anteriorly it extends forward through the fourth ventricle to the anterior region of the third ventricle, where after dividing several times each, division enters the torus longitudinalis posterior and ventral to the posterior commissure. Within the torus the divisions of Reissner's fibre divide many times, becoming eventually distributed to the ectal region of the optic lobes. In cross section the fibre shows a thin myelin sheath, and the central portion has a punctate appearance. Studniscka's recent deductions as to the nature of the fibre are shown to be incorrect and drawn from insufficient data.

The development in Amia and some other Teleosts has been worked out. Shortly after hatching some of the neuroplasts in the anterior portion of the optic tectum become differentiated, increasing greatly in size. By the second day after hatching these twenty to thirty cells send out processes which grow downward, penetrate into the third ventricle and growing posteriorly, coalesce to form Reissner's fibre. By the end of the second day this has grown posteriorly through the aqueduct of Sylvius and by the third day through the whole length of the canalis centralis.

The following papers were read by title:

'Ingestion of follicle cells by the ovarian ovum of the rat,' by Maynard M. Metcalf.

'Newly found parallels between dinosaurs and birds,' by Henry F. Osborn.

'Terminal nerve cells in the skin and fate of the lateral line organs in Amphibia,' by C. L. Herrick.

'The nervous apparatus in the saccus vasculosus in *Acipenser*,' by J. B. Johnston.

'The giant cells in the spinal cord of Catostomus,' by J. B. Johnston.

'A suggestion as to the meaning of the periodical degeneration which occurs in some compound ascidians,' by Maynard M. Metcalf.

'New observations upon the structure of Octonemus,' by Maynard M. Metcalf.

'New England species of Glossophonia,' by W. E. Castle.

'Notes on the tracheal system in *Neuroptera*,' by G. C. Scott.

'Demonstration of photomicrographs in cytology,' by Katharine Foot.

'A case of regeneration of the end of a human finger,' by W. E. Ritter.

'On the multiplication of arms in the twenty-rayed starfish *Pycnopodium helianthoides*,' by W. E. Ritter.

'Notes on regeneration and regulation in Planarians,' by F. R. Lillie.

J. S. Kingsley,
Secretary.

SCIENTIFIC BOOKS.

Leitfaden der Kartenentwurfslehre für Studierende der Erdkunde und deren Lehrer bearbeitet von Prof. Dr. Karl Zöppritz *in zweiter neubearbeiteter und erweiterter Auflage herausgegeben von* Dr. Alois Blundau. Erster Theil: Die Projectionslehre. Mit 100 Figuren und zahlreichen Tabellen. Leipzig, B. G. Teubner. 1899.

The first edition of Zöppritz' 'Leitfaden der Kartenentwurfslehre,' a volume of 162 pages, appeared in 1884, and treated of projections, topographical drawing, plotting of itineraries and other matter more remotely connected with the construction of maps, such as the astronomical determination of geographical positions, constructions of geometrical curves, etc. The reputation of the author and the variety of contents secured a favorable reception to the volume, but it is a singular fact that its chief merit, that of opening a warfare upon the almost universal practice of misusing projections, should have been the least appreciated. Zöppritz was the first one in Germany who recognized the far-reaching importance of Tissot's investigations concerning distortions of projections and utilized them for his work, but the innovation was coldly received by German geographers. It was not until two years after Zöppritz' death, in 1887, that Hammer took up the fight and by his masterly translation of Tissot's mémoire succeeded in securing foothold for Tissot's ideas in the German scientific mind, and thus removed the last doubt about an ultimate victory of the principle "that the proper selection of a projection for a special purpose is not, like fashion, a matter of custom and taste, but dictated with analytical rigor," and thus prepared the way for a new edition of Zöppritz' 'Leitfaden.' The first part of this new edition, now in our hands, treats of projections exclusively and will be followed by a second volume, devoted to topographical drawing. No disparagement of the memory of Zöppritz is implied, but a tribute is paid to the sound judgment and industry of his successor, Blundau, for the proper assimilation of the new information and experience accumulated since Zöppritz' death, if I make the statement that the present edition is superior to the first one by a more exhaustive and systematic treatment of the subject in hand, by a general application of Tissot's tests and by the subordination of mere geometrical construction to computation.

The 'Leitfaden' was designed primarily as a guide to students and professors of German universities; and it is a significant indication of the conditions prevailing in these institutions, that Zöppritz should have deemed it necessary to apologize for the introduction of two or three formulas of spherical trigonometry, and that Blundau should make it a rule to avoid calculus; and in several instances, such as in giving the formula for equatorial distances in Mercator's projection, to rather omit the proof.

In passing over the contents of this volume in cursory review, I propose to pause only when meeting meritorious projections, which appear to have been neglected in this country, or such as recommend themselves to cartographers for special purposes.

Azimuthal projections.—This class of projections, although of considerable antiquity, has of late years become almost totally neglected. Many of them possess peculiar properties not found in any other projections which make them well suited for special purposes. Blundau introduces a very salutary departure from the usual practice of treating these projections separately by stating their common properties and the distinguishing features of each kind. It is a common property of all azimuthal projections that every point on the surface to be represented is shown in its true azimuth from a central point, and the distinguishing feature of each kind is the particular function of the spherical zenith distance of the point from the center of the map which is adopted as a measure of its distance, or $m = f(\delta)$, where m represents the radius or distance from the center of the map, and δ the zenith distance. The first projection coming under consideration is *Postel's*, in which the distances are given by the arcs

($m =$ arc δ). No projection can be devised which gives *all* distances correctly; Postel's gives the correct distance from one point, the center of the map; but for a limited area, even one as large as the United States which requires zenith distances of 21°, the error in distances is much less than in any of the other projections in common use, not excepting the polyconic, and it is to be greatly recommended for such maps as railroad and post-route maps. The most important one of these projections however is *Lambert's equivalent*, which gives distances by the chord ($m = 2 \sin \frac{1}{2}\delta$), because it gives true areas which for most ordinary purposes is the most desirable requisite. It would be most admirably suited for census purposes; for accuracy of distances it is inferior to the preceding one but superior to the polyconic. [For 20° zenith distance Blundau gives the elements of linear distortion for Postel's as follows: Tangential direction $a = 1.021$; central direction $b = 1.000$, and for Lambert's $a = 1.015$, $b = 0.985$.] In the *gnomonic* projection radial distances are given by the tangents of the zenith distances ($m =$ tang δ) it has the valuable property possessed by no other projection, that all great circles are represented by straight lines. For this reason it is a valuable adjunct to sailing charts, and the Hydrographic Office has published charts of all the great oceans on this projection. This is also a perspective projection with the point of view at the center of the earth. The *orthographic* projection, in which the sines of the zenith distances are taken as radii ($m = \sin \delta$) may also be regarded as a perspective one, it interests us only in so far as all lunar charts are constructed on it, in fact, cannot be constructed on any other. The *stereographic* projection which has the formula $m = 2$ tang $\frac{1}{2}\delta$ deserves mention on account of its antiquity, having been already used by Hipparchus (160–125 B. C.), and it is the only azimuthal projection which has no angular distortion or in which every circle is projected as a circle. It may also be treated as a perspective projection if the point of view is taken on the surface and the earth is assumed to be transparent; the map will then appear reversed like the type of a print. Amongst the conventional azimuthal projections I wish to call attention to one proposed by Hammer in Petermann's Mitt. of 1892, which consists of a Lambert's azimuthal hemisphere converted into a full sphere by a manipulation suggested by Aitow. This projection appears to be well adapted to replace the Mercator projections in atlases of Physical Geography, and has the advantage over Mollweide's, so often used for that purpose, that angular distortions are greatly reduced, besides being, like the latter, equivalent.

Conical Projections.—The transition of azimuthal projections into conical projections is effected by substituting the apex of the developing cone in the place of the center of the map, and by reducing the azimuthal angles in a common ratio, *i. e.*, multiplying them by a constant factor, which in the *ordinary conical projection* is the cosine of the polar distance of the tangent parallel. This *ordinary conical projection*, in which the central parallel and the distances between the parallels only preserve their relative values, while all other parallels and areas are exaggerated, should be used only where facility of construction is the principal, and accuracy a subordinate consideration. Two different methods are in use for compromising the exaggeration of the parallels. In the first one two parallels instead of one are given their true dimensions, one at half the distance between the lowest parallel and the middle one, the other at half the distance between the middle and highest parallel. The radii of the concentric parallels are prescribed by the condition that the latter shall retain their true distance from each other. This method is usually called that by an *intersecting cone*, which designation is misleading for the reason that the cone thus constructed is an ideal one which cannot be directly applied to the sphere; Blundau proposes to call it the *De L'Isle conic projection* after the French astronomer who made the first use of it. The second modification of the conical projection which is also frequently used in atlases, was devised by Mercator and should be called after him. Here also two parallels are given in their true dimensions, just as in the preceding projection, but the radii of the concentric parallels are not those of an ideal cone, but those furnished by a cone tangent to the middle parallel; the meridians no longer cross the parallels at right angles, nor do they meet in one point, the apex of the developed cone. By sacrificing the equidistance of the parallels, conical projections may be constructed which are either equivalent or conformal (without angular distortions) and yet retain either one or two true parallels. Lambert and Gauss have devoted considerable study to these projections; but there is one, devised by Albers in 1805, which has equivalence and two true parallels, qualities which should entitle it to special consideration, but hitherto it has not received any special trial. Amongst the pseudo or conventional conical projections, Bonne's occupies the first rank; although as long ago as 1880, Tissot exposed its glaring defects, it has nearly up to the present date retained almost undisputed possession of the principal atlases. This has sometimes been ascribed to *undue French influence*, but it may just as well be a consequence of custom and convenience. It is somewhat surprising that after all that has been said by Tissot and Zöppritz the 'Geodetic International Association' should persist in making use of Bonne's projection in their reports.

Transverse polyconic Projection of the United States
Drawn by A. Lindenkohl.

Regarding the *polyconic projection*, devised by the Coast Survey and very extensively used in this country, Blundau has not much to say that might be considered as very flattering. He says in substance that the distortion which in the equi-distant conic projections is most perceptible near the upper and lower borders is here shifted to the more distant parallels, and that it is of real advantage only when applied to the representation of regions of predominating meridional dimensions. It is a fact that in maps of the United States on this projection, like those issued by the General Land Office, the Geological Survey and the Census, the exaggeration of the meridians and areas near the Atlantic and Pacific borders reaches fully 6½ per cent., which is nearly three times as much as might be considered a fair allowance, and it seriously interferes with the use of these maps for the measurement of either distances or areas near these borders. But there are several methods by which the undoubted advantages of the polyconic projection can be preserved and its disadvantages greatly reduced, to which Blundau cannot be an entire stranger. One way would be not to adhere strictly to one central meridian, but in the case of an oblique map to shift the apices of the tangent cones in such a manner that the central meridians pass as nearly as may be through the middle of the map; the meridians would then assume a spiral shape. I have used this method on several occasions, but Hammer is the first one, I believe, who has called public attention to it. If the map should have a predominating east and west dimension, the developing cones may be applied in a transverse position; some great circle passing centrally through the map might be treated as a central meridian and the poles might be transferred to the equator. In the accompanying sketch I have constructed a projection of the United States on this principle; the 95° long. is substituted for the equator and the great circle, which in lat. 39°, is perpendicular to the meridian of 95°, is taken as central meridian. The distortion, which in an ordinary polyconic projection, accumulates near the right (east) and left (west) borders is here transferred to the vicinity of the upper (north) and lower (south) borders.* It may not be amiss to mention that for certain purposes Blundau has recommended the employment of abnormal conic projections, in which case the axis of the cone does not coincide with the axis of the earth and gives as illustration a map of Africa, in which the point in which the equator intersects the western coast of the continent is chosen as apex of the cone. On this projection the elements of distortion show very favorable conditions, but it has the serious defect of leaving a blank space by the complete development of the cone on a plane, and since Hammer has shown in Petermann's Mitt. of 1894, that just as favorable conditions may be attained by an equivalent azimuthal projection, the application of abnormal conic projections does not appear to deserve much encouragement. The *polyhedral* projection has a trapezoidal shape. It is now generally adopted in Europe for the single sheets of serial publications of government surveys on a large scale (between 1/20000 and 1/100000); it is similarly used by the U. S. Geological Survey, and has been proposed by Penck for the prospective map of the world on the one millionth scale. It is the shape which any part of the earth's surface, enclosed by two parallels and two meridians will assume in many kinds of projections now in use, provided the size of the section is small enough (not more than 15 or 30 minutes or one degree of latitude and longitude) to allow the substitution of the chord for the arc of the parallels. Consequently this so-called polyhedral projection, properly speaking, is no projection at all; the separate sheets may be joined in different ways, such as will conform to either a polyconic or to a simple tangent conical projection.

Cylindric Projections.—The transition from conic to cylindric projections takes place when the constant factor (n) of the azimuthal angle becomes 0. In this case the meridians become straight parallel lines and the contact occurs at the equator. This great circle as well as the parallels appear also as straight lines, intersecting the meridians at right angles. These conditions are common to all cylindric projections, and the only difference between the several varieties consists in the particular function of the latitude $y = f(\phi)$ which is adopted as measure for the distance of the parallels from the equator. If the meridional arcs are given in their true dimensions ($y = \text{arc}\ \phi$) we have the *square* projection which should not be used for more than 15° from the equator. For broader zones an 'intersecting' cylinder should be substituted (corresponding to the intersecting cone of the De Lisle's projection) which will transform the square into a rectangular projection. The cylin-

* In the polyconic projection the lines of equal linear (and areal) distortion are parallel to the central meridian, and the distortion for modern distances increases as the square of the distance from this line. [Distortion $= 0.01\left(\frac{\Delta}{8^\circ.1}\right)^2$ where Δ = distance from central meridian in degrees of arch of great circle.] Since the distance across the United States from north to south, is only about three-fifths of that from east to west, it follows that by the above manipulation the maximum of distortion is reduced from 6½ per cent. to about 2½ per cent.

der may also be made tangent to a meridian instead of the equator by which the square projection is changed into Cassini's, which, for moderate distances from the central meridian, greatly resembles the polyconic. Cylindric projections may also be made equivalent ($y = \sin \varphi$), when we obtain Lambert's equivalent cylinder projection, but it is only when it assumes that shape (called *conformal* by Gauss and *autogonal* by Tissot), in which there is no angular distortion, or in which the elementary arcs of longitude and latitude preserve their relative dimensions, when $y = \log$ nat. tang $(45° + \frac{1}{2}\phi)$, that this projection, as the Mercator, has attained an importance which puts all others into the shade. The vexatious question of nearly fifty years standing whether the Mercator or polyconic projection offers greater advantages for hydrographic charts, does not appear to have been finally settled yet. Granting that sailing by the *orthodrome* is preferable to sailing by the *loxodrome*, and that the polyconic gives the *orthodrome* in a more nearly straight line than the Mercator, this departure from a straight line may assume sufficient proportions to render the polyconic chart unreliable while, with the positive knowledge that, with the exception of Meridians and the equator, all great circles are curves on the Mercator chart, no sailor will meet with any difficulty in laying down *orthodromes* on a Mercator chart without calculations with the assistance of a gnomonic chart; but the chief argument in favor of Mercator charts will always remain the facility of laying down positions and courses. For hydrographic charts which are not intended to be used as sailing charts, or which are on such large scales that the sea area occupies but a narrow margin, the employment of theMercator projection should be avoided for the reason that the differences within the narrow limits between the two contending classes of projections are sufficiently small to allow the use of a polyconic for the same purpose as the Mercator chart, but they are great enough to render a Mercator chart unfit for most of the uses a map may be put to, such as the measurement of distances and areas. Another very extensive use to which the Mercator projection has been put is for planispheres in atlases, especially for the purpose of disseminating and illustrating information of a statistical or physical nature, and here Blundau is slightly mistaken if he assumes that in this capacity it could very properly be superseded by projections of less objectionable features. For many purposes, for meteorological charts for instance, it is of greater importance to have the cardinal directions, north and south, east and west always point the same way and remain parallel to the borders of the chart, than to have correct areas and to have these lines run in every possible way. The objection so frequently raised against the Mercator projection that it does not furnish any indications for the courses of great circles, may readily be overcome by constructing on transparent paper a system of great circles which intersect the equator in two opposite points. If, however, the Mercator chart is used to illustrate conditions in which correctness of area is more important than parallelism in identical bearings, like those showing density of population, or the distribution of animals and plants, it may very properly be superseded by others of an equivalent nature; if no other, by Mollweide's which is very easily constructed, and always available.

The closing chapter about projections treats of the selection of one with least distortion and gives a résumé of the results of Tissot's investigations with tables giving the relative values of the elements of 'deformation' for the principal projections in use, reducing the formerly often troublesome question about the relation of a projection for a special purpose to one of easy solution. But this applies only to maps embracing large areas, as those of continents; the question about the projection with least distortion for areas of restricted size, such as European countries, does not admit of a general solution, but has to be solved for each country separately and this solution is definite. In no such case would the projection be one admitting geometrical construction; it would be one entirely dependent upon analysis.

Having carefully perused the volume from beginning to end, I conclude that it is an eminently practical book and gives to the cartographer all the information he may possibly need regarding the nature of projections and their constructions; but it is because of this utilitarian tendency, together with Blundau's manifest aversion to cross the threshold of higher mathematics, that to the disciples of Gauss, Lagrange and Tissot (who care more for the theory than for the application of projections), the treatment of 'autogonal' or 'conformal' projections is not altogether satisfactory. He should have introduced the elements of the theory of functions without which a proper treatment of these projections is impossible. He should at least have said that the coördinates of a sphere (u, v) are connected with those (x, y) of Mercator's projection by the relation

$$x + iy = u + i \log \operatorname{tang} \left(\frac{\pi}{4} + \frac{v}{2}\right)$$

and that by suitably taking Φ, the coördinates of any other autogonal projection (X, Y) are given by the relation

$$X + iY = \Phi\,(x + iy).$$

If $\Phi(\ \ ) \equiv e^{\pm i(\ \ )}$ a stereographic projection is obtained in which the north or south pole is the center of the map. If to this stereographic projection we apply $\Phi(\ \ ) \equiv -K + \mathrm{cn}^{-1}(\ \ )$, we obtain Peirce's *quincuncial* projection, etc.

A. Lindenkohl.

December 28, 1899.

The Evolution of General Ideas. By Th. Ribot. Translated by Frances A. Welby. Chicago, Open Court Publishing Company. 1899. Pp. 231.

The scope and mode of treatment of Professor Ribot's monographs are well known; and this one follows closely the general plan of those which have preceded it. The topic itself is a most interesting one; the genesis of the powers of abstraction and the evolution of the general ideas which represent the fruit of such abstraction. The material for the early forms of the process is to be found in the mental operations of animals, of children and savages, and of deaf-mutes before education. These have, in common, the absence of words and the dependence of the abstraction upon the generic images formed by sense-experiences. The intermediate stage involves the use of words and is reflected in the character and growth of language. The word fixes the material basis of the abstraction and aids the mind in focusing upon the 'abstracted' relation. In the highest stages of abstraction the element of representation has faded away, and the word practically constitutes its entire content. Following the description and illustration of these processes is a special consideration of the development of the special concepts of number, space, time, cause, law and species. The fundamental insistence upon experience as the basis of such development and the suggestiveness of the genetic point of view find apt application in this part of the thesis.

But in spite of a well-chosen theme and of a discerning utilization of the literature; in spite of much interesting material and suggestive modes of treatment, the general impression of the book is a rather unsatisfactory one. There is a judicious occupation of points of advantage; skirmish lines are thrown out in various directions, a campaign is carefully planned—and the planning is rather too freely discussed—but there is no vigorous nor successful attack upon the real stronghold of the situation. None the less, the monograph will be a helpful one to the student, who will appreciate the significance of the problem, as Professor Ribot outlines it, and who will be led by the interest of the exposition to assimilate the essential factors involved in the growth and functioning of the powers of abstraction. His attention may be specially directed to a point touched upon in the last chapter, but worthy of more extensive treatment; namely, that the criterion of the utility of abstraction is not to be sought merely in its products—such as the higher mathematics or metaphysics—but as well in the process itself, by which the individual learns to focus the attention at will upon any aspect of a complex experience which may become important. And, in the same chapter, he should not overlook the suggestive delineation of the parts played by theory and practice, by the incentive of genius and by gradual development, in the actual history of the sciences depending upon abstraction.

Of the translation, the best that can be said is that it is barely satisfactory. A good translation of a psychological work involves the absorption and re-expression of the author's perspective of ideas, not of his words alone;

abundant Latinisms, ambiguous phrases, and awkward statements reveal that this process has not been very successfully accomplished in the present instance.

JOSEPH JASTROW.

UNIVERSITY OF WISCONSIN.

BOOKS RECEIVED.

Plane Trigonometry. DANIEL A. MURRAY. New York, London and Bombay. Longman's Greeen & Co. 1899. Pp. xiii + 95.

Irrigation and Drainage. F. H. KING. New York and London, The Macmillan Company. 1899. Pp. xxi + 502. $1.50.

The Logical Bases of Education. J. WELTON. London and New York, The Macmillan Co. 1899. Pp. xvi + 288. $1.00

Muscle, Brain and Diet. EUSTACE H. MILES. London, Swan, Sonnenschein & Co. New York, The Macmillan Company. 1900. Pp. xv + 339.

Elementary Chemistry. ALBERT L. AREY. New York and London, The Macmillan Co. 1899. Pp. xi + 271. 90 cents.

Plant Structures. JOHN M. COULTER. New York, D. Appleton & Co. 1900. Pp. ix + 348.

Central Station Electricity Supply. ALBERT GAY and C. H. YEAMAN. London, Wittaker & Co. New York, The Macmillan Co. 1899. Pp. xiii + 467. $3.00.

Water and Water Supplies. JOHN C. THRESH. Philadelphia, Pa., Blakiston's Sons & Co. 1900. Pp. xx + 438. $2.00.

A Text-book of Physics. W. WATSON. London, New York and Bombay. 1899. Pp. xii + 896. $3.00.

SCIENTIFIC JOURNALS AND ARTICLES.

THE New York Botanical Garden has begun the publication of a monthly journal to contain notes, news and untechnical articles of general interest. It is edited by Dr. D. T. MacDougal, director of the laboratories, and is sent free to members of the Garden. The first number, containing sixteen pages, opens with an article on the Museum building by Dr. N.L. Britton, with a plate, and this is followed by short unsigned articles on 'Coöperative Forestry,' 'Etiolated Plants as Food,' 'Micorhizas of Orchids' and 'Colors.' At the end there are notes on recent accessions to the Gardens and on other subjects of botanical interest. The New York Botanical Garden now has four series of publications. The *Journal* just mentioned, the *Bulletin*, containing official documents and technical articles, *Memoirs* and *Contributions*, the latter being reprints from other journals.

THE December number of the *Bulletin of the American Mathematical Society* contains a report of the October meeting of the Society, by the Secretary; 'Note on the Simply Transitive Primitive Groups,' by Dr. G. A. Miller; 'On the Commutators of a given Group,' by Dr. G. A. Miller; a review of Oltramare's 'Calcul de Généralization,' by Professor E. O. Lovett; 'Shorter Notices'; 'Notes'; 'New Publication.' The January number of the *Bulletin* contains the Presidential Address of Professor R. S. Woodward. 'The Century's Progress in Pure Mathematics,' delivered at the annual meeting of the Society, December 28, 1899; 'The Status of Imaginaries in Pure Geometry,' by Professor Charlotte Angas Scott; 'Notes'; 'New Publications.'

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

AT the 94th meeting and 7th annual meeting, held December 13, 1899, the following officers were elected for the ensuing year: *President*, Whitman Cross; *Vice-Presidents*, J. S. Diller, C. W. Hayes; *Treasurer*, M. R. Campbell; *Secretaries*, F. L. Ransome, David White; *Members-at-large of the Council*, G. P. Merrill, Bailey Willis, A. H. Brooks, Waldemar Lindgren, G. O. Smith.

THE 95th regular meeting was held January 10, 1900. Under informal communications Mr. G. P. Merrill exhibited and briefly described a nepheline-melilite-basalt from Rocky Hill, Oahu, where it had been found in place by Professor C. H. Hitchcock. It was stated that while a rock of this type had been previously described by Wichmann and others from fragments brought by vessels as ballast, this was, it was believed, the first discovery of the rock in place.

Under the regular program the following papers were presented:

(1) Mr. Joseph A. Taff: 'Structural Features

of the Ouachita Mountain Range in Indian Territory.'

This mountain range is 200 miles long and trends west from the vicinity of Little Rock, Arkansas, into Indian Territory. It is separated from the Ozark uplift on the north by the east and west trough of the Arkansas valley. It is abruptly terminated on the east by the Tertiary overlap of the Mississippi embayment. The Cretaceous peneplain comes up on the south side of the range and Cretaceous rocks conceal much of the structure. On the west the strike of the folds turns toward the south, and the latter pass under Cretaceous sediments. As far as known, the rocks involved in the Ouachita uplift are Silurian shales, sandstone, limestone, and novaculites—2560 feet; Lower Carboniferous (Branner)—18,480 feet; and Upper Coal Measures—5300 feet; making a column nearly five miles in thickness. The sandstones become thicker and coarser toward the south.

The structure of the range is Appalachian. In the center of the range the folds, in massive sandstone, are wide and long. Near the periphery the folds are shorter and generally overturned, compressed and faulted. Some of the faults have vertical displacements of several thousand feet. The uplift began before or during the Carboniferous and culminated after that period.

(2) Mr. Geo. P. Merrill: 'The Gem Mines near Bakersville, North Carolina.' Specimens were shown and a brief account given of the pegmatitic veins in which the beryls (emeralds and aquamarines) occur.

(3) Mr. Arthur C. Spencer: 'A Peculiar Form of Talus.'

In some of the high basins of the San Juan Mountains, Colorado, the encircling cliffs have supplied at certain points an excess of débris, which has advanced across the floor of the glacial cirque as a tongue, simulating the form of a small glacier. The slope of these lobes may be as low as one in six, and their thickness may reach fifty feet. The surface of the talus-stream shows, in each case, a series of roughly concentric ridges, suggestive of differential and periodic downward movement. The chief force involved has doubtless been gravity, acting upon the mass of loose rock. The movement within the mass may, however, have been facilitated by interstitial ice derived from sifting snow or percolating water.

F. L. Ransome,
David White,
Secretaries.

BIOLOGICAL SOCIETY OF WASHINGTON.

316TH MEETING, SATURDAY, JANUARY, 13TH.

W. R. Maxon exhibited an abnormal flight feather from the peacock, in which the shaft was double for nearly its entire length.

William Palmer exhibited a series of specimens of *Onoclea sensibilis* showing variations due to conditions of environment, such as shade, exposure to light, moisture or dryness.

Vernon Bailey told 'Where the Grebe Skins come from,' and how the birds are killed by thousands among their nests on the lakes of eastern Oregon and California. Three species, the western, the eared, and the pied-billed grebe were found breeding among the tules in the shallow waters of Tule Lake, California, and here the hunters were engaged in shooting the old birds, stripping the skins from their breasts and shipping them to San Francisco. From twenty to fifty cents were received for a skin and the hunters were making from twenty to thirty dollars a day. At the present rate of destruction the birds will not last many years and the speaker raised the question, can they not be protected?

William Palmer spoke of 'the Ferns of the Lower Shenandoah Valley,' illustrating his remarks by specimens, showing their variation as compared with similar species from the vicinity of Washington due to the conditions under which they grew. In the case of every species but one the valley habitat was the dryer of the two resulting in the production of narrower fronds and less herbaceous plants. The deforestation of the valley and the grazing of sheep and cattle have caused the almost complete extermination of ferns, except in favored and very rocky localities, among the limestone bluffs and mountain streams. Many species common about Washington, and growing luxuriantly in wooded situations, were either absent or represented by few examples and these reduced in size and starved.

J. W. Daniels described 'Zoological Collecting in Cuba' speaking of the richness of the fauna and the difficulties that attended the work owing to the thickness of the vegetation.

E. L. Morris presented 'a Revision of the Species of *Plantago*, commonly referred to *P. Patagonica* Jacq.' stating that a number of distinct species had been combined under this name or its variety *gnaphalioides*, some of which were as yet undescribed. The species could be divided into two groups, distinguished by the form of the bracts, *Plantago Patagonica*, the speaker stated did not occur in North America.

T. W. STANTON,
Secretary.

WASHINGTON CHEMICAL SOCIETY.

THE regular meeting was held on January 11, 1900. The following officers were elected for the ensuing year: *President*, Dr. H. C. Bolton; *Vice-Presidents*, Mr. V. K. Chesnut, Dr. Peter Fireman; *Secretary*, Mr. William H. Krug; *Treasurer*, Mr. W. P. Cutter; *Executive Committee*, the above officers and Messrs. Wirt Tassin, E. E. Ewell, H. N. Stokes, F. K. Cameron and W. F. Hillebrand.

WILLIAM H. KRUG,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

IN addition to the program as announced for the January meeting of the New York Section of the American Chemical Society, Dr. George F. Barker, of the University of Pennsylvania and a past president of the Society, was present and made a very interesting address on the more recent developments growing out of the Röntgen ray investigations, describing and exhibiting a sample of radium or 'Radio-Active Substance A,' as named by the German chemists who are working on the subject. This substance emits rays which cause an impression of feeble phosphorescence to the eye, but which are not light. In other words, they are rays which cannot be reflected nor refracted. Nor can they be prevented from acting on a photographic sensitive plate by three thicknesses of black paper added to as many thicknesses of orange yellow paper; and images were shown on a plate which had been made through all this thickness of protective covering.

Few people have had the opportunity of seeing this substance, and Professor Barker's address was listened to with the closest attention.

Mr. Allen Hazen exhibited lantern slides 'Illustrating Filters for Purifying Public Water Supplies,' many of them taken in different foreign cities, but the largest number showing the process of construction and the finished work of the immense covered filter beds at Albany, which are capable of delivering about 9,000,000 gallons a day.

J. A. Mathews read a paper on 'Laboratory Method for Continuous and Uniform Generation of Acetylene and its Purification' and 'Upon the Carbide of Gold'; C. W. Volney, 'On the Reactions of Alkalis with the Cellulose Nitrates.

Dr. McMurtrie, the recently elected president of the society at large, was present, and made a short address, expressing his appreciation of the honor conferred by his election, and the hope that he would receive the hearty cooperation of all the Sections of the Society.

Nearly one hundred members and friends were present, and the first meeting of the new year gives promise of increasing interest and enthusiasm in the work of the Section and of the Chemists' Club, the rooms of which prove so satisfactory for the purposes of the Club as well as for the meetings.

DURAND WOODMAN,
Secretary.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO.
MEETINGS OF OCTOBER AND NOVEMBER, 1899.

AT the first session of the Club on October 18th a paper entitled, "The Significance of the 'Spiral Type' of Cleavage" was read by Mr. C. M. Child. The paper was the result of observations upon the cleavage of *Arenicola* and *Sternaspis* supported by a comparison with the cleavage of other forms which show the same type. The principal points urged are briefly as follows: the cleaving egg must be regarded as an organism, not merely as a cell colony or cell mosaic. Differentiation and cell division, even in the spiral type of cleavage, are independent phenomena, though they may coincide more or less closely in point of time. The spiral type must have been originally due to mechanical causes, but is certainly, at present, hereditary. It is followed by a bilateral form of cleavage which is morphogenetic in character, *i. e.*, the direction and time of division and the size of the cells all contribute directly to the establishment of form in the embryo. This bilateral cleavage has encroached upon the preceding spiral period in consequence of a condensation of the process of development. The determinate character of the cleavage makes possible the massing of large amounts of material in certain cells, which thus become centers of distribution, but this segregation is quantitative rather than qualitative so far as 'organ forming material' is concerned. An adequate conception of the extreme plasticity of the cell is necessary for a satisfactory interpretation of the phenomena of spiral cleavage.

The second session of the Autumn Quarter was held November 1st. Mr. R. H. Johnson read a paper reviewing and criticising some of the recent statistical literature upon the subject of variation. A second paper was contributed by Mr. E. R. Downing reviewing the experiments of Loeb, Morgan and others on the production of cell division and development in unfertilized eggs by chemical reagents.

At the third session, November 15th, Mr. J. M. Prather contributed the results of his study upon the development of the hypophysis in *Amia.* The hypophysis arises about one hundred and sixty hours after fertilization, as a local differentiation of hypoblastic cells in the dorsal wall of the fore-gut far back of the point of union of fore gut with stomodæum. Here the base of the fore-brain is in very close contact with the hypoblast, and this fact indicates that its point of origin is determined by physical factors. Lobes begin to form about the fifteenth day and by the thirty-fifth day the organ is much lobed, chiefly around the edges. The first lumen appears near the center during the ninth day, while others form in the lobes as they arise. The lumina appear to have no communication with each other or with the exterior. Neither blood-vessels nor nerves, nor glandular secretions could be found in it at the latest stage examined. The saccus vasculosus begins to form about the tenth day, as an evagination at the posterior lower angle of the infundibulum and grows backwards under the base of the hind-brain. It is thus quite remote from the hypophysis at all stages. Granular secretions were found in it as early as the twenty-second day. It is inferred that what Kupffer considered the earliest stage of the hypophysis in *Acipenser* is the anterior diverticulum of the fore-gut which is metamorphosed into the adhesive organ.

The second paper, read by Miss Anne Moore, was an account of the morphology and life history of *Dinophilus*, *D. Gardineri*, found at Woods Holl. Miss Moore succeeded in observing the actual encystment of *Dinophilus*, thus accounting for the sudden disappearance of the animal noted by other authors.

The fourth session, November 29th, was devoted to a paper by Mr. V. H. Lowe entitled, 'Photographing Insects and other Animals.' Mr. Lowe described in detail the apparatus and methods employed in photographing animals in the field and in the laboratory, including both living and mounted specimens. The paper was illustrated by a number of the author's lantern slides.

C. M. Child.

OTTAWA FIELD-NATURALISTS' CLUB.

The third of the series of Winter Soirées was held in the Assembly Hall of the Y. M. C. A. on January 9th. There was a good attendance of members and strangers. Zoology, ornithology and geology formed the topics of the evening. Professor E. E. Prince, B.A., F.L.S., Commissioner of Fisheries for Canada gave a most instructive paper 'On the Comparative Anatomy of the Ear,' in which he traced the unity of arrangement in the structure and mechanism of that organ from the lowest organism up to the highest, specially adapted to receive vibrations and impart them to the nerves connected therewith. By means of a beautiful series of exquisitely prepared original slides thrown upon the screen, Professor Prince illustrated the anatomy of the 'true ear' in jelly-fishes, mollusks, birds, fishes, snakes and vertebrates. An interesting discussion followed this paper in which Messrs. Kingston, Evans, R. B. Whyte, besides the lecturer, took part.

Mr. Andrew Halkett of the Marine and Fisheries Department, then read his paper 'On Gannets and Cormorants, with special reference to Canadian forms.' His paper was full of interesting notes of observations in the field and on the shores of the Atlantic and Pacific in British North America.

(1) 'Note on the Occurrence of *Remopleurides* in the Upper Trenton (Ordovician) of Ottawa, Canada; (2) 'On a new species of *Turrilepas* from the Trenton limestone of Governor's Bay, Ottawa, Canada,' are the titles of two brief papers presented by Dr. H. M. Ami. Brief descriptions of each were given and the salient points of dffference between them and their nearest allies indicated. The *Remopleurides* is new and nearer *R. Canadensis*, Billings of the Chazy, whilst the *Turrilepas* (opercular valve) is distinct from the only form known from the Ordovician of the Ottawa Valley, viz.: *Turrilepas Canadensis* Woodward, described in 1880, from the Utica formation.

Dr. Ami then drew the attention of the members present to Professor W. H. Hobb's paper 'On the Diamond Field of the Great Lakes,' a subject of considerable importance, and gave an abstract of the results reached from a careful scientific enquiry into the facts relating to the eight specimens of diamonds discovered in glacial and other gravels of Wisconsin, Ohio and Michigan—in material which came over during the glacial period from Canada. This paper was illustrated with lantern slides as was also the next 'On the Principal Places of Geologic Interest about Ottawa,' in which several interesting sections were given and the attention drawn to work still remaining to be done. Mr. A. E. Barlow's paper 'On the Bridgewater Conglomerates,' was taken as read owing to the absence of the author from town. Interesting discussions took place on the specimens exhibited at the meeting and other points of interest in connection with the papers read.

DISCUSSION AND CORRESPONDENCE.

BUCKLEY ON THE BUILDING AND ORNAMENTAL STONES OF WISCONSIN.*

PROFESSOR MERRILL'S review of this book I have read, † and in some respects it seems to me to do an injustice to Dr. Buckley.

A State Geological report may be reviewed from the point of view of the citizens of a state, or as a report primarily designed for scientists. It is the latter view which Mr. Merrill, who is connected with a national institution, has naturally taken. The book is objected to upon account of its size. This criticism is perfectly justified from the point of view of general science. However, the citizens of the State of Wisconsin interested in the stone industry desire detailed descriptions and tests of the stones furnished by each of the important quarry centers of the State. Therefore the publication of this material is fully justified in a State report. Of course, the reader who is interested only in science may omit this part of the subject.

In respect to crushing strength tests, of which Mr. Merrill speaks so lightly, whether he is right or not in reference to their uselessness, they must be made in order to promote the building stone industry in a state, for the strength of a stone is one of the questions which an architect invariably asks, and therefore one which the owner of the quarry must be able to answer provided he wishes to put his stone on the market.

Moreover, beside being justified on account of the local value, Dr. Buckley's strength tests do contain material which is of general scientific interest. For instance, Dr. Buckley finds that a number of the limestones of Wisconsin have the enormous crushing strength of 30,000 to 40,000 pounds per square inch (p. 392). Also a number of granites in Wisconsin have crushing strengths which run between 40,000 and 50,000 pounds per square inch (p. 390). The strengths of these rocks are unparalleled by any previous rocks tested. They therefore have an important bearing upon the general scientific question of the depth of the zone of fracture.

* Bull. No. IV. Economic Series No. 2. Wisconsin Geological and Natural History Survey. 1898.

† SCIENCE, N. S., Vol. XI., No. 262, pp. 24–25.

Of Dr. Buckley's explanation, p. 383, of the unfavorable action of freezing temperatures, Mr. Merrill says there is 'an unconvincing air of freshness.' For my own part, I think Dr. Buckley is correct in his explanation of the resistance which many porous rocks, like sandstones, exhibit to alternate freezing and thawing, while other rocks which may contain no more than one per cent. of pore space suffer severely under such conditions. This matter cannot be fully expounded in this review, but Dr. Buckley's explanation in brief is that in rocks in which the pore spaces are large and connected, the water is drawn off or distributed by capillarity, leaving the pore space only partly filled by water. When this water freezes there is room for expansion within the pores without rupturing the rocks. On the other hand, in some rocks in which the pore spaces are very small and discontinuous, the pores remain entirely filled by water, and when they freeze the expansion ruptures the rock (pp. 20–25, 374–375). Dr. Buckley's conclusion is fully warranted by his experiments, which show that fine-grained, compact limestones and granites which have a very small pore space, often lose more in strength by freezing and thawing than do the sandstones having a large percentage of pore space. I am not aware that experiments have before been made which show the actual effect of freezing and thawing on the strength of the rocks. Nor have experiments shown the relation of the size of the pores to the diminution in strength due to freezing and thawing, and Dr. Buckley's results on this point are believed to have economic value. However, whether this be so or not, they have a scientific value bearing on the disintegration of rocks in the belt of weathering.

Another matter discussed, upon which Dr. Buckley has made a contribution of general value to the science of geology, is the more accurate determination than has heretofore been done of the pore space of rocks. Tolerably well indurated sandstones he finds to vary in pore space from 10 to 20 per cent., or more, and in one case, that of the Dunnville sandstone, the pore space is over 28 per cent. (pp. 402–403). These results are of great importance as showing the actual amount of material which must be added by underground waters in order to completely cement a rock. From Dr. Buckley's results it is a safe inference that in the cementation of clean sandstones to quartzites, there must have been contributed by underground waters at least one-quarter of the entire volume of the rocks. In determining the pore space of building stones, their specific gravities have also been obtained by a method more accurate than has heretofore been used.

Dr. Buckley's observations on joints in the State of Wisconsin (pp. 458–459, Pl. 49) have an important bearing upon structural geology. These observations are shown upon the map and indicate that the dominant joints of the sedimentary rocks of Wisconsin are in nearly vertical position and in two sets nearly at right angles to each other, trending NW–SE and NE–SW. The position of these joint systems with reference to the folding has an important bearing upon theoretical structural geology which cannot here be discussed. In connection with certain structural work of my own I have searched for such information in many volumes, but nowhere else have I found a set of observations upon joints over so wide an area.

In conclusion it seems to me that the size of Dr. Buckley's book is justified by the necessity of putting in a State report the information which the people of the State wish. It seems to me further that the report differs from a number of previous State reports in containing considerable material which is of general value to geology.

C. R. Van Hise.

HYDROSTATIC VS. LITHOPIESTIC THEORY OF GAS WELL PRESSURE.

The paper read at the Orton Memorial Meeting at Columbus, entitled 'Edward Orton Geologist,' and published in Science, January 5th, contains a reference to Professor Orton's theory of nature of gas and water pressure in gas wells that calls for some comment.

The writer has for some time not been entirely satisfied with the 'Hydrostatic Theory of Gas Pressure.' He noticed that Professor Orton, himself, a short time before he died, expressed himself in a way as to indicate he was not altogether satisfied with his own theory.

Certain wells had been bored in New York that exhibited a pressure of 1500 pounds to the square inch. Professor Orton confessed that he was unable to suggest where the hydrostatic head sufficiently high to produce this pressure might be located; though in explaining the pressure in the Ohio and Indiana Trenton gas wells, he had gone as far as Wisconsin to get a head sufficient to explain pressures of approximately 450 pounds to the square inch. It has always seemed to the writer that Professor Orton's adduced argument here fell short of a demonstration. Even admitting that the Trenton rock is continuously porous under cover from Ohio and Indiana Gas Fields to outcrop 600 feet above sea-level in Wisconsin (a condition implicitly denied elsewhere, when he explains barrenness of Trenton rock in gas under area surrounding the 'gas belt' by the 'compactness of the rock'), it would still be necessary to suppose that the columns of 'Trenton brine' rising to 600 feet above sea-level in the wells, were balanced by a corresponding body of water of like specific gravity saturating rock up to the very limit of outcrop. Such an explanation calls for the saturation of Wisconsin surface Trenton with Ohio and Indiana Trenton brine. Further, it would appear that the argument is specious that would infer hydrostatic character of cause from similarity of 'observed' pressure in wells to that calculated for them from the height to which salt water rises in neighboring abandoned wells. Of course this would be so, no matter what the nature of the cause which produced the pressure. As well argue that the pressure of the atmosphere is 'hydrostatic' in origin, because it holds up a column of water a certain height between sucks in a pump.

In view of the objections above mentioned, may it not be necessary to revive the much derided theory of 'Rock pressure'—for which the term 'lithopiestic' is proposed? In the light of facts brought out in connection with the development of the petroleum industry in recent years, many of the objections urged against this theory no longer obtain. An examination of 'bituminous sandrock' from deposits which are nothing more than old petroliferous beds formerly deeply covered by overlying strata, but now exposed by denudation and with contents oxidized, shows that the bitumen takes the place of cement in other sandstones. In other words, it was accumulated before the rocks were consolidated, or (in accordance with the 'anticlinal theory') its accumulation accompanied their consolidation. In this condition the rocks were compressible, and with them their gaseous and fluid contents. Such compression could be the result both of weight of overlying rocks and lateral pressure—the latter the same which produced the anticlinal and synclinal folds permitting of a separation of the contents in accordance with their specific gravities. When a body of strata is thrown into gentle folds without fracture, some of the beds must almost certainly undergo compression. It would appear that a bed of bituminous shale, for instance, in contact with a bed of porous, but perhaps non-compressible, sandstone or limestone, would have some of its gaseous and fluid contents driven into the interstices of such rock and held there under pressure. Such pressure would become manifest whenever the rock was penetrated by the drill.

There are a number of phenomena connected with artesian and gas wells which are probably better in accord with the 'lithopiestic' than the 'hydrostatic' theory. One of these is the sensitiveness of pressure to tremors and movements of the earth.

One experiment suggests itself that would probably determine whether this pressure is in the main 'hydrostatic' or not. If all abandoned cased wells in a district can be filled up to the top of the casing or higher with surface water, which water will remain at that level, the pressure which held the original salt water to a certain level in the well could not be hydrostatic exclusively.

The contention here is not that none of the pressure is hydrostatic (doubtless water is mainly the medium through which it is communicated), but that for certain deep artesians and all high pressure gas wells the ultimate source of the pressure is mainly lithopiestic.

ARTHUR M. MILLER.

STATE COLLEGE OF KENTUCKY.

HEARING IN ANTS.

IN a recent number of SCIENCE (Nov. 24, 1899), LeRoy D. Weld describes some experiments upon a number of species of ants, demonstrating a sense of hearing. It may be of interest to record that in 1895 one of my students, Miss E. A. Wagner, who was keeping several species of ants under observation, found one species (not determined) of small black ant which gave unmistakable evidence of hearing. Miss Wagner's work was never completed, so that I can only give, from memory, an inadequate account of her results.

To most sounds this species, like the others studied, was apparently indifferent, and, so far as we could judge, insensible, but to a note of a certain pitch, whether sounded by a violin or by a whistle, the whole colony would react most vigorously, rushing about frantically, tumbling against one another, many of them falling into the water moat surrounding the nest, a thing they never did when undisturbed The appearance was that of extreme agitation. This response was obtained only to sounds of a certain pitch. On first sounding the note the ants which might be resting quietly in a compact group in the nest (asleep?) would apparently be startled to attention, standing tense with erect antennæ. A few of the outermost ants in the group would usually move about a little, but if the sound was not repeated they might return and all the individuals again become quiet. If the sound were repeated several times at intervals the agitation (?) would steadily increase until all the ants seemed fairly frantic, behaving in a way never observed under other circumstances. The reaction was equally decided whether the note was sounded near the nest or fifteen feet away at the opposite side of the room with the back turned to the nest. In only one species was any response observed, and in this species the response was only to a note of a certain pitch.

It is difficult to explain the violent reaction to only this particular note. What connection, if any, it may have with any features of the normal environment of these ants, I cannot suggest.

MAYNARD M. METCALF.
THE WOMANS COLLEGE OF BALTIMORE.

NOTES ON INORGANIC CHEMISTRY.

AFTER having been practically stationary for a number of years, the manufacture of sulfuric acid, which is the greatest of the chemical industries, has lately begun to make new and unforeseen advances. The first of these is the use of cast-iron vessels for concentration and is described by E. Hartmann in the *Chemiker Zeitung*. The great rise in the price of platinum has emphasized the necessity of some more economical material for concentration vessels, and it is found that, unless it is desired to have an acid absolutely free from iron, vessels of cast-iron can be used. The iron should be as free as possible from all impurities and as hard as possible. The acid is concentrated in lead pans to 61° *B*, then run into a small cast-iron vessel in which it reaches 63.5°–64° *B*, at a temperature of 180°. Finally it is run into two concentrating dishes in cascade arrangement, where a strength of 97% to 98% is obtained. The small vessel lasts three to four months and the concentrators from six months to over a year. The loss on wear of apparatus is however no greater than with platinum, and the first cost is insignificant in comparison.

THE second advance in sulfuric acid manufacture is nothing less than a complete revolution, and is described by Lunge in the *Journal* of the Society of Chemical Industry. It is the complete abolition of the lead chamber and towers, even of the use of nitrous fumes as oxygen carriers, and the use of the so-called catalytic power of platinum and other substances to occasion the union of sulfur dioxid and oxygen. In other words it is the utilization of an idea which has long been considered available for the preparation of sulfur trioxid and Nordhausen fuming acid. The Badische Anilin and Soda Fabrik has perfected this invention and is manufacturing its acid practically by this process and other firms are beginning to follow in its steps. Among the catalytic agents which have been used are pyrites, cinders. The principle feature of the Badische invention is the discovery that to obtain good results it is necessary to get rid of the heat of the reaction. With this it is possible to attain 98 per cent. of efficiency. The process is of course of greatest value for producing the strongest acid, and avoids especially any necessity for concentrating plants. For weaker acid, such as chamber acid, it is probable the old process will always be more economical. The new process has, however, the further advantage of giving an acid exceptionally pure and especially free from arsenic. This would seem at the present outlook to be the most important advance in technical chemistry in the last few years.

J. L. H.

*CAMBRIDGE UNIVERSITY**

A COMMENCEMENT has already been made with the new Geological Museum which will cost about £44,000, of which sum the fund raised as a memorial to Professor Sedgwick will supply £27,000. The contributions to the Benefaction Fund have made it possible to consider the erection of new buildings for Law, part of the funds for which will, it is understood, be contributed by the trustees of Miss Squire's will, for Medicine, Botany, Archæology and rooms for business purposes and examinations; but it is impossible to say until plans have been drawn and estimates made whether the resources of the University will allow of the erection of all these buildings at the present time.

Although the extreme pressure upon the funds of the University is thus removed and some of the most urgent of long-standing claims can be satisfied, the response made as yet to the Chancellor's appeal will not allow of any of the new developments of University work which many friends of the University consider opportune. In the interests of national progress it is greatly to be desired that laboratories of applied science should not be isolated, but should be established in connection with schools which are already strong in pure science. Technical training in any limited sense of the expression is impossible. In every subject of practical application, whether it be a learned profession or an industrial art, success depends upon breadth of knowledge of the sciences upon which the profession or art is based. Advances in technology are almost invariably due to the application by practical men of principles discovered by those who carry out investigations in pure science. Conversely the strength and vitality of the school of pure science is largely increased when opportunities are afforded to students of passing on to its applications.

The remarkable progress of Natural Science in Cambridge is closely associated with the growth of the Medical School. During the past twelve years a larger number of students have entered for the Natural Sciences Tripos than for any other examination for honors, notwithstanding the fact that but few students are in a position to allow their prospects in life to depend upon the discovery in themselves of a special aptitude for pure science. Almost all those who have since distinguished themselves in various branches of science have commenced their career by preparing to qualify for a profession. The majority of the graduates, for example, who are at present prosecuting researches in the physical, chemical, botanical, zoological, physiological, anatomical and pathological laboratories, making, to the great credit of the University, additions to knowledge which are not exceeded, if they are equalled in amount, by any other university in the world, entered as medical students. The phenomenal growth of the Engineering Department under Professor Ewing is also beginning to produce similar results; students who entered with the intention of becoming engineers have discovered in themselves a special aptitude for pure mathematics or for physics in one of its various branches. Thus experience shows that whereas there can be no doubt as to the advantages which a professional or technical department reaps from the support of a school strong in pure science, the advantages which pure science reaps from the proximity of departments of applied science are not less substantial. An examination of the class-lists, as well as the records of work done after graduation, shows with equal clearness that the older subjects of university culture do not suffer from the rivalry of new departments.

* From the report of the retiring Vice-Chancellor, Dr. Alexander Hill, Master of Downing College.

GRADUATE STUDY AND THE SMITHSONIAN INSTITUTION.

IT will be remembered that a committee representing the American Association of Agricultural Colleges and Experiment Stations requested the Smithsonian Institution to consider the organization of post-graduate study in Washington. The matter has been considered by a committee of the regents, consisting of ex-Senator Henderson, President W. L. Wilson, Professor A. Graham Bell, President James B. Angell and Representative Hill, which has drawn up a report that concludes as follows:

"The committee does not hesitate to express its warm and decided sympathy with the general purpose of the movement thus made by the associated colleges. The object sought commends itself to us all, and the zeal and ability with which it has been pressed upon our consideration by the very able and distinguished educators and scientists connected with these colleges furnish ample assurance that the consummation of the great and leading object sought by them is only a question of time. The material already collected in the bureaus and departments of the government furnishes a rich mine of the educational wealth that will not be permitted to remain forever undeveloped. This material is now being constantly enriched by the most valuable additions to its present enormous wealth. Already it has invited to the national capital many distinguished scientists, anxious to avail themselves of the superior advantages thus offered for investigation and research.

"Your committee, however, is painfully impressed with the fact that the powers of the Smithsonian Institution as at present organized are scarcely broad enough to embrace the work proposed. And the committee is equally impressed with the fact that even with enlarged authority its present financial condition would absolutely prevent anything like efficient and creditable performance of the work contemplated.

"It is well known to the members of this board that a great wealth of material—material which would be of immense utility in the successful accomplishment of the purposes indicated by the associated colleges—lies buried in the crypts and cellars of the National Museum.

"If our institution is unable for want of room, as it undoubtedly is, even to place this valuable material on exhibition for the public eyes, and as little to arrange it for scientific uses, the problem of providing halls for lectures and meeting the necessary expenditures incident to the work proposed becomes serious and formidable in the extreme. Your committee is not prepared to make definite recommendations to the board for its final or ultimate action. That which is clearly inexpedient to-day may become not only expedient but eminently desirable to-morrow."

THE MISSOURI BOTANICAL GARDEN.

FROM advance sheets of the administrative reports for 1899 of the Missouri Botanical Garden, it appears that as contrasted with the preceding year there was a slight increase in revenue, and that by a decree of the Supreme Court of the State of Missouri, affirming a decision of the lower court, handed down some years since, the Trustees of the Garden are now empowered to sell real estate originally inalienable, which, when improved, should sell for at least $1,500,000. The Garden expenses for the year were $32,174.36, in addition to which a small sum was spent on special improvements.

The Director's report shows that 71,021 visitors to the Garden were counted during the year, and that the collection of living plants, which included 8009 species and varieties at the beginning of the year, made a net gain of 1118, bringing the total at the end of the year up to 9127.

There were 32,890 sheets of specimens incorporated in the herbarium, which now comprises 340,350 sheets. The additions to the library comprise 642 books, 172 pamphlets, and 9042 cards, bringing the contents of the library at the end of the year up to 33,462 parts, of which 14,287 are books, and 19,175 pamphlets. The total value of the herbarium is now stated to be $51,052.52, and of the library $54,683.24.

It is stated that as a result of the recent decision of the Supreme Court touching the unimproved real estate constituting a part of the endowment of the Garden, the Trustees are now able to look forward to the gradual conversion of a large amount of unproductive, heavily taxed property into an income-producing form, while relieved from the need, which they have experienced during the past ten years, of withholding a large part of the current revenue annually for the protection of this property whenever the improvement of the streets through it should be ordered by the city. As a first step in the marked advance to be looked for, the Trustees have authorized the immediate grading of about twenty acres of ground adjoining the present Garden, according to plans prepared some years since by Olmsted, Olmsted & Eliot, the intention being to plant this area as a permanent addition to the grounds, in such a way as to add greatly to their attractiveness and to present in a compact form the leading features of the North American flora, which it is proposed to arrange essentially in the well-known botanical sequence of Bentham and Hooker; while some eighty acres adjoining are expected to be improved within a few years, in accordance with plans furnished by the same landscape architects, in such a manner as to represent as many as possible of the natural orders of plants, so arranged as to exemplify the more modern classification of Engler and Prantl.

SCIENTIFIC NOTES AND NEWS.

THE American Academy of Arts and Sciences has granted from the income of the Rumford fund $500 to Professor E. C. Pickering, for the purpose of carrying out an investigation on the brightness of faint stars by coöperation with certain observatories possessing large telescopes, and $100 to Professor T. W. Richards, in aid of a research on the transition points of crystallized salts.

COLONEL F. F. HILDER, of the Bureau of American Ethnology, has just been detailed as a special agent of the Government Board of the Pan-American Exposition, to visit the Philippines, for the purpose of making scientific and especially ethnologic collections. It is his plan to visit as many of the islands as practicable before the opening of the rainy season, and make collections illustrating the industries, modes of life and social conditions prevailing among both the wild and settled tribes.

MR. EDWARD G. GARDINER, Secretary of the Marine Biological Laboratory, accompanied by Mr. George M. Grey, Collector and Curator of the Supply Department, have left for Puerto Rico for a few week's tour along certain portions of the coast, with the intention of examining and making collections of the marine fauna. Mr. Gardiner expects to have the companionship and assistance of Admiral Grinell, retired, who is familiar with the language and mode of life in this island.

SIR MICHAEL FOSTER, professor of physiology in the University of Cambridge, one of the secretaries of the Royal Society and last year president of the British Association, has consented to become a candidate for the University of London's seat in Parliament, vacant by the elevation of Sir John Lubbock to the peerage.

THE Hon. Richard Olney has been appointed to the vacancy in the Board of Regents of the Smithsonian Institution caused by the death of D. P. Johnston.

DR. H. C. BOLTON has been elected president of the Chemical Society of Washington, and Mr. Whitman Cross president of the Geological Society of Washington.

PROFESSOR MILNE-EDWARDS has been elected vice-president of the Paris Academy of Sciences.

DR. F. FREIHERR VON RICHTHOFEN, professor of geography at Berlin, has been given the Bavarian Maximilian order for art and science.

DR. E. R. SCHNEIDER, professor of chemistry at Berlin, has been given an order of the crown on the occasion of the celebration of the fiftieth anniversary of his doctorate. The same order has been given to Dr. Felix Klein, professor of mathematics at Göttingen.

M. TH. RIBOT, professor of psychology of the Collège de France, has been elected to the chair of the Paris Academy of Moral Sciences made vacant by the death of M. Nourrisson.

PROFESSOR HENRY S. CARHART of the department of physics of the University of Michigan, who has been spending the year in Germany, is now in Zürich studying the subject of electrical engineering with Professor Weber.

PROFESSOR W. P. MASON, of the Rensselaer Polytechnic Institute, has gone te Europe to be absent until May.

THE president of the Local Government Board, London, has appointed Mr. William Henry Power, F.R.S., the assistant medical officer and medical inspector for general sanitary purposes of the Board, to the office of medical officer of the Board, in the room of the late Sir Richard Thorne Thorne, K.C.B. Dr. H. Franklin Parsons has been appointed assistant medical officer and medical inspector for general sanitary purposes, and Dr. R. Bruce Low has been appointed an assistant medical officer.

WE regret to record the death of Dr. John E. Davis, professor of mathematical physics in the University of Wisconsin.

WE regret also to record the death, on January 23d, of Professor Henry A. Hazen, one of the chief forecasters of the U. S. Weather Bureau at the age of 50 years. Mr. Hazen was killed as the result of a bicycle accident which occured the day before.

THE death of David Edward Hughes, F.R.S., is announced at the age of 60 years. He was the author of numerous papers on electricity and magnetism and the inventor of the Hughes printing telegraph instrument, of the microphone and of the induction balance. He had received the gold medal of the Royal Society and the Albert Medal of the Society of Arts.

THE death is also anounced of Mr. H. T. Coxwell at the age of 81 years. With Mr. Jamer Glaisher, F.R.S., he made in the early sixties a number of balloon ascents, including a noted one to a height of seven miles, which yielded important contributions to entomology.

THE following deaths have also occurred among men of science abroad: Dr. Karl Friedrich Rammelsberg, formerly professor of chemistry, in the University of Berlin, on December 29th, at the age of 86 years; Dr. Giovanni Zoia, professor of anatomy at Pavia, and M. Mather, the mineralogist, of Marseilles.

M. CAURO, assistant professor of physics at the Paris School of Pharmacy, has been killed while making experiments on Mt. Blanc on the interruption of the electric current through ice.

AT the meeting of the Academy of Natural Sciences, of Philadelphia, on December 26th, a life-size portrait of Linnaeus was presented to the Academy by Mr. Charles E. Smith. It is a copy by Mr. Boude-Wijnse of the original portrait belonging to Baron Verschuer at present in his country house near Haarlem. In an interesting letter read before the Academy, Mr. Smith states that he had been searching for the portrait for about 20 years, and explains how he had overcome the difficulties in finding the picture and securing the copy.

THE Torrey Botanical Club has appointed a committee to prepare a program in commemoration of the life and work of Dr. John Torrey, to be presented before Section G, of the American Association for the Advancement of Science, at its meeting in New York, in the last week of June, 1900.

THE will of Ex-Chief Justice, Chas. P. Daly, made, it appears, in addition to the public bequests already noted, a bequest of $20,000 to the New York Botanical Garden, payable on the death of his wife's sister. The Garden also receives one-twelfth of the residual estate.

MR. and Mrs. Samuel M. Nickerson have given to the Art Institute of Chicago, their entire art collection, said to be the most valuable private collection of ivories and rare oriental carvings in Chicago, and the second in value in the United States.

THE annual meeting of the Board of Regents of the Smithsonian Institution was held at Washington on January 24th. The report of Secretary Langley for the year ending June 30, 1899, was presented and accepted.

THE House Committee on Agriculture has authorized a favorable report on the bill to reorganize the Weather Bureau, the chief provisions of which were described in a recent issue of this JOURNAL.

THE New York Botanical Garden announces among recent accessions, a gift of 25 microscopes from Mr. W. E. Dodge, to be used as part of the permanent display in the Museum; the greater part of the botanical library of the late Dr. Hossack; a herbarium, containing many valuable specimens, from Mr. John J. Crook; 200 drawings made by the late Professor August

Koehler, and plants from Mr. H. P. Kelsey and Mr. Nathaniel Thayer.

M. MAURICE LÉVY, in assuming the Presidency of the Paris Academy of Sciences, in January 2d, made two requests, as follows: "La première, que nous commencions toujours nos séances à l'heure réglementaire; ce sera d'autant plus expédient cette année que le public comprendra souvent des étrangers, envers lesquels, citoyens d'une République, nous devrons observer cette vertu des rois: l'exactitude; la seconde, qu'au cours de nos séances, notre attention, qui est toujours très grande, veuille bien toujours se montrer aussi silencieuse qu'elle est grande.

IT is stated that Herr Vaze, the German Polar explorer will lead an expedition into the Arctic regions next summer in the hope of finding traces of Andrée.

ON the 20th of February Mr. A. P. Low of the Geological Survey of Canada, who has explored the Labrador Peninsula during the past eight years and only recently returned from an eighteen months' sojourn in that once but little-known land, will deliver a lecture upon the Labrador Peninsula under the auspices of the Ottawa Field-Naturalists' Club in the Academic Hall of Ottawa University. The lecture will be illustrated with lantern slides.

IT is reported that the Navy Department and the Lighthouse Board of the Treasury Department have declined to accept the terms offered by Mr. Marconi's representative, and will make experiments with a view to developing an independent method of wireless telegraphy.

THE Fifth Section of the International Congress of Comparative History to be held at Paris during the Exposition is a congress on the history of science. The *British Medical Journal* states that the object of the promoters is to bring together persons interested in the study of the history of the various sciences, and to prove to them that it will be to their common advantage to work together, so as to render the study of original documents easier. The Organizing Committee, of which M. Paul Tannery is president, has drawn up a long list of subjects which are considered to be ripe for discussion. Proposals for schemes for encouraging the study of the history of science are also invited. The Congress will have an independent organization and will be held from July 23d to July 28th. The official language will be French, though papers in German, English or Italian will be received. Further information can be obtained from Dr. Sicard de Plauzoles, Rue St. Dominique 124, Paris. Among the committee are Professor Paul Berger, Prince Roland Bonaparte, Professor Brissaud, Professor Hahn, the Prince of Monaco, Prince Henri d'Orleans, Dr. Pozzi, and Professor Charles Richet.

THE London *Times* states that at the meeting of the British Astronomical Association, on December 27th, Mr. Maunder made a statement with reference to the arrangements that are being made for the proposed expedition to Spain and Algeria, to view the solar eclipse of May 28, 1900. He said that, subject to a sufficient number of passages being actually taken before January 31st, the Royal Mail steamer *Tagus* or a sister vessel would be engaged, and would start from Southampton on Friday, May 18th, at 6 p.m., calling at Cadiz and Alicante, and arriving at Algiers at 6 a.m., on Thursday, the 24th. The vessel would stay there until after the eclipse, leaving at 6 a.m., on Tuesday, the 29th, and calling at Alicante, Gibraltar, and Lisbon on the way to Southampton, which would be reached at 7 a.m., on Monday, June 4th. It was hoped the members of the Association would divide themselves into three groups—those observing the eclipse (1) in the interior of Spain: (2) at Alicante or neighborhood, and (3) in Algeria, where the ship would act as hotel for those who might wish to use it in that capacity. The first party would, it was expected, break up into two chief sections—those who would alight at Cadiz and rejoin the ship at Alicante, and those who would rejoin the ship at Gibraltar. The entire party would thus have the opportunity of visiting Gibraltar and Lisbon. The latter port, however, would only be visited in case it was quite free from plague infection. In case a sufficiently large party should wish to alight at Cadiz and visit the chief cities of Southern Spain, arrangements would be made with Messrs. T. Cook and Sons for tours to Seville, Cordoba, Granada, and other places of interest. All these arrangements, however, would fall through unless a sufficient number of passages had been definitely engaged before January 31st.

AT a recent meeting of the British Departmental Committee on preservative matters in food, Professor A. Wynter Blythe testified according to the *London Times*, that formerly it was quite rare to find aniline dyes in food, the simpler forms of colors, such as cochineal and burnt sugar, being used, but latterly it was quite rare to find natural colors. The rule and not the exception now was to use so-called tar colors. Dye was not largely used in coloring wine, as the grape gave it a sufficiently nice color. In no substance, however, which he had examined would the quantity of aniline dye, even supposing it to be poisonous, be enough to injure health; but having regard to the many things colored in this way, it was a question whether the collective amount which a child, say, might take in a day might not have some injurious effect. The great majority of these dyes were not poisonous. Injurious, as distinct from harmless, colors should be scheduled. There would be little difficulty in prohibiting aniline dyes and in detecting a breach of the prohibition. Such a prohibition would be useful, and the drawing up of the schedule would be easy for some central authority, say the Local Government Board, or the Board of Agriculture. It should be made the duty of the vendor to declare the presence of coloring matter. As to boracic acid in milk, he did not approve of treating an almost universal article of food with a drug, unknown to the consumer, but it would be very difficult to forbid it altogether in, say, London, where the bulk of the milk came from the country, and where much would be spoilt unless a preservative were used. Here also the presence of the preservative should be notified. Salicylic acid was not much used except in temperance drinks to arrest alcoholic fermentation. Mr. Richard Bannister, Fellow of the Institute of Chemists and of the Chemical Society, and late Deputy-Principal of the Inland Revenue branch of the Government Laboratory, said bacon was at present brought into England with the aid of borax; it would not be possible to bring it over in refrigerators, as was done with fresh meat, except at a great increase of cost, and even then it would not be in exactly the same condition as at present, or equally fit for the English market. Both in the bacon and butter trade he considered preservatives a necessity. There would be no objection to making it obligatory on the vendor of milk to notify the presence of a preservative, but there would be difficulty in stating the amount, because it was difficult to estimate its amount. Salicylic acid was chiefly used in British wines and liquids which were presented in a clear form, and in which there was not a sufficient quantity of alcohol to make them clear and bright.

UNIVERSITY AND EDUCATIONAL NEWS.

PRESIDENT SCHURMAN has announced an anonymous gift of $80,000 for Cornell University to erect a building for physiology and anatomy.

BY a decision of the New York Court of Appeal, Yale will receive the $150,000 bequeathed by William Lampson.

PRESIDENT BASHFORD of the Ohio Wesleyan University announces that Mrs. Elizabeth Mebarry of Richmond, Ind., who recently gave $50,000 to the university, has added $10,000 to the fund, thus endowing two chairs.

A COURSE in landscape architecture to extend through four years has been arranged by the Lawrence Scientific School of Harvard University.

THE trustees of the University of Cincinnati have declared vacant nine of the twelve professorships, and one of the remaining three professors has since resigned. The instructors and assistants also retire.

MR. S. T. DUTTON, Superintendent of Schools in Brookline, Mass, has been elected professor of school administration in Teachers College, Columbia University.

THE *American Geologist* states that Mr. A. G. Leonard has charge of the geological work at the University of Missouri in the absence of Professor Marbut.

SCIENCE

FRIDAY, FEBRUARY 9, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ON THE ABSORPTION OF CONDENSATION-PRODUCING ATMOSPHERIC DUST BY SOLID NUCLEI AND SURFACES, AND ON THE DIFFUSION VELOCITY OF SUPPOSEDLY NON-IONIZED DUST PARTICLES.**

LET r be the radius of a tube stretched along the axis X, and conveying dust-laden air at a velocity, v. Consider two sections at a distance dx apart; the dust entering per second at the near face is $\pi r^2 nv$; the dust leaving per second at the rear face is $\pi r^2(n + [dn/dx]dx)v$, if the air current is kept constant and n is the density of dust distribution, or is proportional to the number of particles per cubic centim. On the other hand, the absorption of dust particles by the walls of the section in question, is $k \cdot 2\pi r \cdot n \cdot dx$, where k is the absorption per square centim. per second, per unit of dust concentration, and the absorption, as a first hypothesis, is taken proportional to the density of distribution of particles in air.† Hence $-\pi r^2(dn/dx)dx \cdot v = k \cdot 2\pi r \cdot n \cdot dx$,

or $$\frac{dn}{n} = -\frac{2k}{vr}dx. \qquad (1)$$

Let the density in case of air saturated

* Preliminary report of work made with a grant of the Smithsonian Institution, and published by permission of the Secretary.

† Briefly k is the diffusion velocity of the dust particle, *i. e.*, its normal velocity in air at rest. Equation (1) neglects the spontaneous dissipation of dust particles. This is permissible for the fast air currents v of Table I. The full equation is treated below.

with dust be taken as one. To determine the constant of integration it is to be observed that when $x=0$, or $k=0$, there is no absorption; but the current of air must nevertheless be kept up passing either through the absorption tube or not, to retain a colored field in the color tube. Now saturated dusty air would be objectionable seeing that an opaque field is produced unsuitable for measurement. Hence even when $x=0$, or $k=0$, the influx current is unsaturated, and we may suppose this minimum current to be obtained through a fixed initial length of tubing, x_0, of the same kind. Thus the tube virtually begins at $-x_0$, and equation (1) becomes on integration

$$n=e^{-\frac{2k(x+x_0)}{rv}}. \qquad (2)$$

If the observations be so made that the dust density issuing from the length x of tubing is constant, we have for a given color tube, $n=n'$ and

$$\frac{x+x_0}{v}=\frac{x'+x_0}{v'}. \qquad (3)$$

For different tubes under the same conditions,

$$k/k'=\frac{vr}{x+x_0}\Big/\frac{v'r'}{x'+x_0}.$$

Hence, ignoring the undeterminable constant, one may write briefly

$$2k=vr/(x+x_0). \qquad (4)$$

With this preliminary theory as a point of departure, I have been making an extended series of observations on the condensation of supersaturated steam obtained from jets, and following the general method of color tubes described in my memoir * on the subject published by the U. S. Weather Bureau in 1895. By passing measured quantities of air (V litres per minute), saturated with the emanation of phosphorus, through different lengths of absorption tubing,* and regulating the air current by a graduated stop-cock till a definite color (full blue) appears in the field of the color tube, the condition $n=$ constant is fulfilled, on provision that no change has occurred in the action of the tube during the interval. As V is the influx of dusty air per minute, $1000v/60=\pi r^2\cdot v$, and as $2k=vr/(x+x_0)$,

$$k=\frac{2{\cdot}65}{r}\cdot\frac{V}{x+x_0},$$

where $V/(x+x_0)$ is given by the observations of volume in terms of length of absorption tube for a fixed blue in the field of the color tube. If V_0 be the minimum volume, *i. e.*, the influx volume of dusty air corresponding to $x=0$, $k=2.65/r\cdot V_0/x_0$; hence, finally,

$$k=\frac{2{\cdot}65}{r}\,\frac{V-V_0}{x}. \qquad (5)$$

Aside from the difficulty of observing subject to color criteria, equation (3) is well borne out by the data obtained, to the extent that V is a linear function of x. V_0, however, does not always coincide with observation, and a certain additional tube length must in certain cases be added to compensate for the dissipation (eddies?) encountered on entering the absorption tube. But this is non-essential.

A brief summary of the present results is given in the following table, which shows the material of the absorption tubes, their diameter, the variations of length (x) and volume (V) occurring in each series of experiments (usually 10 or 20 in number). The pressure under which steam issues from the jet is shown under p (centims. of mercury), and the temperature (°C.) of the air flowing into the color tube, under θ. Within reasonable limits, discussed elsewhere, the color tube is not sensitive to

* A Report on the Condensation of Atmospheric Moisture; Bulletin, No. 12, pp. 104, U. S. Weather Bureau, Washington, 1895.

* Ordinary tubing used for absorption purposes, *i. e.*, to catch the dust particles moving laterally out of the dust-laden air current.

either of these variations. The table also gives the ranges of the velocities of dust-laden air through the absorption tubes resulting from the differences of length, and the limit of values computed for k showing the errors of measurement. The final column contains the mean value of k obtained from the data as a whole.

to be seen whether greater refinements of method* will rather bring the k-values to coincide for all condensing surfaces or accentuate differences.

At all events, it is already clear that the velocity of the phosphoric dust particle is independent of its density of distribution.

In the Bulletin cited, the work of which was done in 1893, and elsewhere,† I denied that colored cloudy condensation was ever due to ions, a theory then rife and particularly discussed by the younger v. Helmholtz, Bidwell and others. None of these investigators have, to my thinking, made out a clear case. Since the advent of the X-rays and of the brilliant work done at the Cavendish Laboratory, however, the status of the question has changed materially. Nevertheless I am still loth to abandon my former conviction that condensation is always primarily due to nuclei; and that whether they are ionized or not (none were certainly known until recently), is a matter of secondary and perhaps negligible consequence. Thus for instance, concentrated sulphuric acid is a dust producer comparable to phosphorus; and yet this is the very reagent that has always been used in drying the chambers of apparatus when high insulation is specially wanted. Certainly one would be rash to thrust the wily ion in such a chamber. Indeed the interest which attaches to the above results is this,

TABLE.—ABSORPTION OF PHOSPHORIC DUST* IN TUBES.

Tube of	Diameter.	Range of Lengths, x	p	θ	Range of V†	Range of v‡	Range of k	Mean k
Gray rubber	.64cm.	0–455cm.	4cm.	26°	.7–7.0	40–360	.08–.12	.123
Pure rubber	.35 "	0–300 "	6 "	24°	.5–4.2	80–740	.12–.16	.137
Lead	.63 "	0–300 "	5 "	27°	.5–4.6	30–250	.15–.18	.162
Lead	.32 "	0–150 "	9 "	27°	.7–2.0	140–410	......	.160
Glass	.29 "	0–150 "	8 "	27°	.8–2.0	200–480	......	132

In view of the widely different values of the velocity with which the dust laden air traversed the absorption tubes, the high velocities employed and the marked difference of material which makes up the absorbing walls, the close proximity of the values of k is particularly noteworthy when the meaning of this constant is called to mind: k being the absorption per square centim. per second per unit density of distribution, is simply proportional to the velocity of diffusion of the phosphorus emanation, or in other words, to the velocity with which the particles ejected from phosphorus by an oxygen reaction travel normally through the surrounding air. In the cases of glass, of impure vulcanized gray rubber, of pure brown rubber, this velocity is so far as observation warrants, the same. In the case of lead tubes the velocity set forth by k is slightly larger, a circumstance which may have an electrical or a chemical bearing, or be referable to the greater density of these tubes. It is entirely premature to speculate upon it. It remains

*Similar results were obtained with dust particles ejected by concentrated sulphuric acid.

† Litres per minute.

‡ Centims. per second.

*The color estimates in the table were made by the eye. It will not be difficult to repeat them relative to some fixed standard blue.

† *Nature*, XLIX., p. 363, 1894.

that strong evidence is afforded in favor of a specific velocity of the particles of a supposedly non-ionized dust, so far as the phosphorous emanation has been known. Since they are always absorbed they must clearly soon vanish out of any vessel, usually within five minutes if considered in bulk. A large part of this dissipation is referable to the grosser dust particles in ordinary air.* Thus if phosphoric dust and a suitable small quantity of smoke of ammonium chloride (made in the usual way) be passed into the color tube, the field which is opaque with phosphoric dust alone, becomes cleared when the sal-ammonium smoke is added. The larger particles of the latter have therefore captured the finer particles of the former (phosphorus emanation); and as sal-ammonium smoke alone, if not itself opaque, is unable to produce colored cloudy condensation or opacity, the field clears at once. Now if sal-ammonium smoke can capture phosphoric dust then it is conceivable that agencies may exist which reverse the fortunes of war and liberate phosphoric dust. Heat is such an agency. If nearly effete dust be passed through a hot tube (say above 400°), experiment showed me that the condensation producing tendency is again restored, precisely as if the dust were dissociable. At a higher temperature still, though not necessarily above red heat, the tube itself becomes an energetic dust producer at its inner walls, even when of glass so that experiments of the present kind are delicate. Indeed long ago I asserted that the strong dust producing activity of flames was a conversion of coarsely disseminated into finely disseminated atmospheric dust, a conversion of the planets of this microcosm into nebulæ, as it were.

One may readily conceive the X-rays to be another such agency. After some trials I devised a form of apparatus appropriate for my purposes, by which the condensational tendency of air energized by X-rays,* shows almost as powerfully in the color tube as does the older dust laden air. So far as the effect of these different kinds of dust on the color field is concerned, one would be unable to distinguish any noteworthy difference of behavior. Both may be carried through tin tubes 2 inches in diameter and over 60 feet long, taking one or more minutes in the transfer, without encountering fatal diminution in the condensation producing power of either. Other and now well known experiments of an entirely different nature go to show that X-ray dust is ionized, or transferred in a region of ionized gas, whereas the ordinary dust, with which I have chiefly worked, is not; but I ask, if both classes of dust are under proper limitations, equally able to induce condensation in supersaturated aqueous vapor, how can one single out the exceptional quality of ionization as the cause of this tendency? It has been brilliantly proved by J. J. Thomson, Rutherford, Chattock, and indirectly by C. F. R. Wilson, that ionized dust has a definite velocity; but in as far as the above experiments have weight, so has the supposedly non-ionized dust.

* This secondary dissipation is neglected in the differential equation (1), being of much smaller order than the surface effect investigated. With the wide tubes (diameter 2 inches), presently to be mentioned, the differential equation replacing (1) above is

$$-\pi r^2 v\, dn/dx = kn2\pi r + k'n^2/v$$

where k' is the number vanishing per second per unit of concentration of dust in air. The last term decreases as v, the velocity of the air current increases. This equation is easily reduced as a case of Riccati's equation, and the integration may therefore be made without difficulty.

* Of course, the X-ray tube must be boxed up most carefully, the rays shining through an aluminum window, and the terminals imbedded in paraffine. Any highly potentialized conductor, like a hot body, is apt to dust the air.

One way of escaping between the horns of the dilemma is to suppose the ionization to exist even when not directly evidenced. Thus most of the dust with which I have worked is derived by oxidation, or by heat implying chemical action or dissociation, or from highly potentialized matter, etc. Phosphoric dust is quite inactive at low temperatures and in a current of air free coal gas. The same is true of molten sulphur. Concentrated sulphuric acid, however, shows increased activity when a current of coal gas is passed through it into the color tube; but the action here is probably a destruction of the coarse dust particles in air, the effect being similar to that referred to in the case of flames. Facing the question squarely it seems extremely difficult to account for a specific velocity in the non-ionized dust particle. Being already stupefied in observing that a much larger volume of air of initially constant dust content must be discharged through a wide tube than through a narrow tube of the same material, and within certain limits of diameter, instanced by the above table, one may well be daunted in confronting the case of a specific velocity in an inert dust particle.

The need of a direct decision is, therefore, urgent; is this phosphoric dust ionized or not; or better, is it generated in an ionized region? Using an electroscope, which in the dry room in which I worked retained its charge indefinitely, I aspirated a current of air across the charged terminal without appreciable result. I then blew air which was passed over phosphorus across the terminal, and found to my surprise that even with a small current the charge was dissipated more than one-half in the first minute. It made no difference whether a positive or a negative charge was on the electroscope. Hence, phosphorus, when emitting condensation-producing dust seems also to emit some form of obscure radiation; for the dust evolution* occurs in a strongly ionized region, or the dust is itself ionized. Relative to the experiments of the above table, therefore, fresh means are at hand for computing the velocity of the phosphoric dust particle, and the electricity carried per gram, in a way similar to the famous researches made at the Cavendish Laboratory, independently of the preceding results. This suggests one method of standardizing the colors of my color tube, absolutely in terms of the number of dust particles per cubic centim. producing the color effect.

With the question thus happily answered in the case of phosphorus, I next examined air passed over concentrated sulphuric acid, but found it without effect even on the electrometer. Though the acid is a weaker dust producer than phosphorus, the present electrical result seems out of proportion to the data of the color tube. The decision made is therefore partial, but I have not advanced beyond it. Other dust producers might be instanced in the same category, and it is for this reason that I have retained the antiquated designation 'dust' in this paper.

I may add that in the experiments which I have under way, I have been dealing somewhat extensively with questions of the above nature, using dust either ionized or not. My methods, however, are all restricted to an application of the steam jet,

* I shall show elsewhere, and have since verified experimentally, that if air energized by phosphoric dust be maintained between the plates of an air condenser, the difference of potential, ϕ, vanishes according to the equation

$$\phi = \phi_0 \, \varepsilon^{-nket}$$

in the lapse of time t, where e is the charge per particle. For different thicknesses, d, of air, the decay of energized dust particles in successive layers of air is very similar to the absorption of light in successive thicknesses of medium, viz., $n = n_0 10^{-\alpha d}$. In my experiments I found $a = .25$, and thus the number of particles is reduced to 1/10 in a layer of air 4 centimeters thick.

since this is an instrument with which I am familiar, and since this mode of attack has not at all been cultivated by the recent investigators on allied questions. The steam jet method has undoubtedly many grave shortcomings; but it has one invaluable advantage of retaining a given color of field for an indefinite interval of time, so long as the conditions of action are left unchanged. My present work has shown me, moreover, that the complicated character of the evidence derived from the jet, is much less serious than I have hitherto supposed. Among the inquiries with which I have been much occupied, is a determination of the number of particles which give rise to a given colored condensation in the field of the color tube, contributing to an optic phenomenon of exceptional interest, the theory of which is as yet quite unknown. Should this phenomenon yield to treatment, there would be given, since there is no serious difficulty in finding the collective mass of the particles, an independent method, and one not depending on electrical agency, of ascertaining both the individual velocity and possibly the mass of these subtle and pervasive dust particles, absolutely. For let m_0 and m be the masses of dust absorbed per square centim. per second in the first and final sections of the absorption tube. Then $n = m / m_0$ and the velocity k in equation (2) is thus the only unknown quantity.

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RECENT OUTLOOKS UPON MUSIC.

THE field of music is too vast to be seen from any single standpoint. The ignoring of this simple truth has led to countless misrepresentations of facts by writers, and misunderstandings of books by readers. For tacitly it is assumed by most of us that there is only one standpoint, indefinitely thought of as that of the modern musical performer or intelligent concert-goer; and if we do recall that some mathematicians praise another point of view, while Greek, Oriental and mediæval musicians apparently had others, we yet know they have been too rarely visited to have much influence on musical thinking.

But the discoveries of the last few years bearing on the questions of the basis of music and the historical development of scales have rendered it possible for the student of comparative music to occupy a point from which many long-known facts appear entirely changed, and older authorities, as Fétis, Helmholtz and Ambros, are seen to be inadequate, if not erroneous. In comparison with this standpoint, that of the modern musician appears to be a rapidly shifting one, like an observation car or the masthead of a ship.

It is the purpose of this paper to review from this new-found standpoint some parts of four rather recent books* of more than temporary interest and value, that deal with various parts of the field; and by their aid to define the musicians' standpoint, and indicate some of the problems now before the student of the history and basis of music.

I.

Klauser's book was the first in order of publication, yet is probably the least known of the four. From title page to conclusion it bristles with novel ideas, developed during, and verified, he asserts, by many years experience in teaching. The hearty pub-

* 'The Septonate and the Centralization of the Tonal System,' by Julius Klauser. Milwaukee, 1890, pp. vi + 274; 'The Art of Music,' by C. Hubert H. Parry. New York, 1893, pp. 374; (The new English edition has the title, The Evolution of the Art of Music); 'Primitive Music,' by Richard Wallaschek. London, 1893, pp. 326–9; 'A Study of Omaha Indian Music,' by Alice C. Fletcher; with a report on the 'Structural Peculiarities of the Music,' by John Comfort Fillmore, A.M. Peabody Museum, Cambridge, Mass., 1893, pp. vi + 152.

lished commendations of such music teachers and writers as W. S. B. Matthews and C. B. Cady, of Chicago, may justify one in feeling that it is more than the work of a dreamer or idle rhapsodist,—that what he has observed of the operations of his own mind in hearing music, can be observed in other minds also.

The introduction is a vigorous plea for 'a higher education in music,' with a severe indictment of ordinary methods for their ignoring sound pedagogical principles. "The *how* is studied before the *what*:" the order should be reversed. "The musician is represented in the *what*, the instrumentalist in the *how*: the two must be combined in one individual. There is a far more important instrument than the voice, piano, organ or violin, whose technique must be developed to a high degree of automatism. This instrument is the mind" (p. 25). "The ready-made tone of the piano is a serious though not an insurmountable obstacle to the development of the mental instrument of the pianist. By the employment of logical methods, the piano is best suited as an auxiliary to a higher musical education" (p. 26). "I have already stated that the mental automatism requisite to a discriminating musician is very great. When an able musician listens to or reads a piece of music, he hears and comprehends all its melodic, rhythmic and harmonic incidents as fast as they take place in a given *tempo*. This means that he listens to music just as he would listen to any familiar tongue. * * * To stop to think is the sure sign that we do not understand" (p. 29). "I have demonstrated in my capacity as teacher that children may be intelligent musicians from the start" (p. 32). "But such results * * * are made practicable only by the simplification of the Tonal system itself. * * * The child requires a simpler foundation than the scale to begin on. The scale-half or tetrachord and the septonate supply this desideratum" (p. 33).

Then follows his novel way of looking at tones and their relations. The first chapter is mainly devoted to definitions; the tones of any series are felt to be either 'reposetones' ('harmonics') or 'progression-tones' ('by-tones'), the latter lying a step or half-step under or over the former (p. 40). A tone is nothing definite until it is relationed in a key, that is, thought and heard in relation with a tonic, which is the point of absolute repose (p. 41). The Tonic is a CENTRAL tone or klang, and the remaining key-klangs are equally distributed *over* and *under* it (p. 42). The seven tones of the scale arranged with the tonic in the center form a *septonate*, composed of two tetrachords or *scale-halves*, an over and an under one: thus,

G—a—b ◡ C—d—e ◡ F.

A key-group contains these seven principals, also five up-mediates (the sharp-notes) and five down-mediates (the flat-notes), or seventeen in all, including five more sharps and five more flats; a full tone-stratum consists of twenty-seven tones; so there are only twenty-seven tonic centers, and only twenty-seven keys in music. Every key has two modes, a bright or major, and a dark or minor mode (p. 51).

In the second chapter it is suggested that "whether we will or not we cannot think a series of tones, even in one voice, except in connection with some harmony," though this is not necessarily conscious (p. 54), and then the attempt is made to prove that the accent determines whether a tone is felt to be a harmonic or a by-tone, and so accent determines harmony (p. 71).

Chapters three and four continue the analysis of tone relations and intervals; there is space only for two points: in a rising scale-half as G to C, the tones may be called Dominant, Passing By-tone, Leading-tone, and Tonic (p. 78): And second, the student should begin with counterpoint and get his earliest intelligence of harmony therefrom (p. 117); for all through attention is directed, not to harmony, but to one governing voice (p. 167).

Chapter five deals with Harmony and six with Suspensions, Inter-relations of keys and Modulation. The boldness of the author's thought about tone-relations appears in such passages as these: "It is plain that any tone and any combination may be relationed in any key. What the presiding key of the moment is, and when a change of key takes place, are matters that are determined by the melo-rhythmo-harmonic inter-relations in which a series of tones appears" (p. 221). "Modulation takes place (even in one voice) at the very moment a shift of relation to another key-center takes place" (p. 253).

The final paragraph is curious: "Since there are twenty-six keys to modulate into from any one key, and twenty-seven ways from one key into each of the others, there are $26 \times 27 = 702$ ways out of and into any one key," and "$27 \times 702 = 18{,}954$ ways in which a prominent voice can modulate" (p. 265).

So much for a meagre presentation of the author's views. While there are many quotable passages in his book, it is strikingly free from quotation, and the very few references to other writers are general, not specific. He objects to Dr. Riemann's theory that major and minor are polar opposites (p. 96), and feels that Helmholtz's explanations are inadequate (p. 270), on which points the reviewer agrees with him. As an offset to his serious discussion he gives a page on nature-music which is more fantastic than Gardner's book of sixty years ago. The student of comparative music notices with interest how this most modern exponent of music interpretation and of music psychology throws away notions of the scale that have been laboriously and fruitfully developed during the last 800 years, to take up the old Greek heptatonic system of two conjunct tetrachords, with *Mese* in the central position, though his are Lydian instead of the usual Dorian tetrachords. And one notices further that by limiting the series to seven tones which are repeated in successive tone-strata, this new system is brought into correspondence with more than one Oriental system; for except among Europeans the eighth note is not usually counted as belonging with the seven, but it starts a new series, and in one case is called by the happy name 'response.'

II.

The reader of Dr. Parry's book feels at once that he is under a master. The author has the degree of Doctor of Music from Oxford, Cambridge and Dublin; he is well-known as one of the leading English composers, and a number of years ago contributed to Grove's Dictionary of Music most of the articles relating to the theory of music: so he was admirably equipped by knowledge of the past, experience as a composer, and maturity of judgment to analyze the musical impulses and expressions of men and to put the results of such analysis into fitting words. Probably no book ever written is so well adapted as this to help the non-musical reader to some understanding and appreciation, both of what music is as an expression of the human soul, and of the artistic means employed in this expression. So far as can be done by one book it brings music back to where the Greeks placed it, to the position of a liberal art, of an instrument of culture as truly as poetry or history or painting; it makes musical training mean something quite other than an accomplishment, or the ability to perform or enjoy a performance, or acquaintance with the history of musicians and their works, or even the power to analyze a musical composition in the usual way. And all his wealth of information and inspiration is poured forth in a clear stream, in language precise and often felicitous, so that one may turn these pages with pleasure even for the style alone.

The earlier chapters throw some light on the subjects covered by the other books under review, and the extracts must be limited to passages bearing on these subjects. In the chapter on Preliminaries, it is pointed out that the intensity of men's pleasures or interest leads to expression; this to be intelligible requires common terms, that is, a design. Design is the equivalent of organization in the ordinary affairs of life. In music especially, form as well as design is necessary, but this book has only to do with design. Music is the expression of what is in man and, therefore, is not mainly imitative. "The story of music has been that of a slow building up and extension of artistic means of formulating utterances which in their raw state are direct expressions of feeling and sensibility." Everywhere are voices, shouts, etc., "but neither music nor speech begins till something definite appears in the texture of its material; some intellectual process must be brought to bear upon both to make them capable of being retained in the mind" (p. 5). "It was not till mankind had arrived at an advanced stage of intellectuality that men began to take note of the relations of notes to one another at all" (p. 6).

"The first indispensable requirement of music is a series of notes which stand in some recognizable relation to one another in respect of pitch" (p. 16). Then follows a thirty page account of the scales used in various parts of the world, which is quite satisfactory, being based mainly on the work of Ellis and Hipkins. While the author avoids the common error of assuming that these were attempts to obtain our scale, he has been misled in some cases by the dogmatism of some of his authorities, as in treating of the Persian-Arabian scale; and he has not got so far away from the modern musician's position as to observe more than what other people have done; their principles and their reasons have escaped him. His "summary is sufficient to show the marvellous variety of scales developed by different nations for purely melodic purposes" (p. 44). Of our scale he says the functions of the notes (dominant, mediant, etc.), are always being expanded and identified with fresh manipulations of the principles of design by able composers: the classification of these functions puts our harmonic scale eight centuries ahead of all melodic systems; and the last stage in this development was the assimilation of all the keys to one another by equal temperament.

In the chapter on Folk-Music, it is pointed out that orderliness and intelligibility in tunes proceed parallel with the general development of capacities in a race. It is very difficult to make out what intervals savages intend to utter. The elements of design that appear among them are repetition, perhaps at different levels, and sometimes the contrast of two short phrases. Tonality marks a considerable advance, and the impression of finality depends on this. The resources of art are not sufficient to allow a long consistent development of a single movement in melodic art; so Orientals fall back on ornament; this is "the part of anything which makes for superficial effect; * * * it generally implies either undeveloped mental powers or great excess of dexterity." In modern German folk-music the harmonic basis is simple and obvious. As art-music grows, folk-music tends to go out of use; for civilization reduces everything to a common level.

From this point on the author treats

only of European music. Harmony came in to help out the church music which was slow and free from marked rhythmic effect. The beginning of harmony is due to the fact that men's voices were of different calibre; only intervals of a fourth and fifth could well be tolerated in simultaneous singing, and so the parts were doubled at these intervals; there is no reason for thinking that this was offensive, as it would be to us. "This doubling does not imply a sense for harmony" (p. 95). Slowly there came in a recognition of the value of different consonances, of discords and of interruptions of the voices. This chapter unfortunately does not recognize the important part taken by the organ in the development of harmonic ideas; the Chinese have had slow sacred music and voices of different calibre for thousands of years, but have no harmony: the organ we believe was the instrument that brought about the development.

In the following chapters Pure Choral Music, Secular Music, Instrumental Music, The Sonata-Form, and Opera are traced from their beginning, with constant reference to the aims and methods of the great composers, and to their share either in enlarging the resources of design or giving expression to human feeling. The temptation to quote at length is very strong. One passage (somewhat condensed) from the chapter on Modern Tendencies will give an idea of the manner of treatment: Palestrina without emotion embodies the most perfect presentation of contemplative religious devotion. Bach * * * formulates a more liberal and energetic type of religious sentiment, and foreshadows by his new combination of rhythm and polyphony the musical expression of every sort of human feeling. Beethoven expresses the complete emancipation of human emotion and mind, and attempts to give expression to every kind of inner sensibility which is capable and worthy of being brought into the circuit of an artistic scheme of design. * * * The love of art for art's sake is at best a love of beauty for itself. * * * This is inevitable at one stage; but humanity as it grows older instinctively feels that the adoration of mere beauty is sometimes childish and sometimes thoroughly unwholesome; and men want to be sure that the human energies are not sapped by art instead of being fostered by it. After both beauty and expression have reached a high plane men seek for strong characterization, as in all the arts to-day, and especially in literature.

Finally, one more quotation somewhat condensed may be commended to the careful study of all who attempt to interpret the music of strange peoples in terms of European music. "Wagner's harmony is the result of polyphony in great measure; he does not abandon tonality, but uses it with quite remarkable skill and perception of its functions; in accompaniment of the ordinary dialogue he is often very obscure in tonality, just as J. S. Bach is in recitative. For straightforward ideas he uses simple diatonic figures; for something specially mysterious, chords which belong to two or more unassimilable tonalities on purpose to create the sense of bewilderment, and a kind of dizziness and helplessness which exactly meets the requirements of the case. If people's sense of tonality were not by this time so highly developed such passages would be merely hideous gibberish, and they often seem so at first" (p. 356).

III.

Wallaschek's book on 'Primitive Music' takes us from the most extreme modern position to the consideration of the beginnings and rude early manifestations of the musical art. The first fifth of it is devoted to a collection of explorer's reports on savage music, little reference being made to peoples who have developed a musical theory, as the Arabs and Hindus. The materials for this chapter have been collected from a wide field, and the reviewer can bear witness to the thoroughness of the search, as he had previously gone over a large part of the ground.

In the following nine chapters much of this matter, with some additions, is arranged under these heads: Singers and Composers; Instruments; the Basis of our Musical System; Physical and Psychical Influence of Music; Text and Music; Dance and Music; Primitive Drama and Pantomime; The Origin of Music; Heredity and Development. Then follows a full Bibliography, an Index and 25 melodies. The author's standpoint is that of a psychologist, as is evident from his papers in *Mind* and in German journals; so he seems most at home in the later chapters.

It is unfortunately true that few of the travellers whose reports are quoted showed any particular fitness to speak on musical questions, or especially to write down correctly as to rhythm and melody the songs they may have heard; so the reports must be used by the student with great care and discrimination. The author's uncritical treatment of his material may be judged from this passage: "In Virginia (North America) for instance, several rattles are tuned together, and the natives have 'bass tenor, counter-tenor, alto and soprano rattles'" (p. 103). On looking for the authority for this statement, made as if true for to-day, one finds it at the end of the book John Smith's History of Virginia; but the date of publication (1624) is nowhere given. Another passage will throw light on the author's judgment of what facts are important and characteristic: After referring to musical contests for endurance among savages he says: "Barbarian as it may appear to be such performances are still in use in America, the modern counterpart being the 'musical' contest which took place at Huber's Museum, New York, on the twenty-third of October, 1892"; the lady played the piano 16 hours 52 min., her competitor, a man, 17 hours; she received five proposals of marriage (p. 72)! Must we confess that America is not entitled to the barbaric preëminence tendered her, for the *London Musical Times* tells of a man who played the piano in public for twenty-five hours consecutively, again for thirty-six hours, and again for forty hours.

In connection with the present review, Chapter IV. is of most interest, for in it are presented the similarities between savage music and ours; the matter is arranged under the three heads of: (1) Harmony, (2) Major and Minor Key, (3) The Scale. Much is made of the facts that various reporters tell of savages singing in two or several parts; the Hottentots especially are said to have keen ears, to be able to give excellent imitations of German hymns after once hearing them, and to employ harmony. The author concludes, "thus neither harmony nor the germs of counterpoint are entirely unknown to primitive nations, and it would seem from all the examples that I was able to collect that the principle of tonality is in most cases unmistakable" (p. 142). It cannot too positively be declared that such a statement is misleading, and in the sense that most readers will understand it, is utterly false; the musical dictionaries give six meanings for the word 'harmony'; it is only by using the word in a very loose and unusual way that it can be applied to the simultaneous singing of any savages yet reported; the use of the terms counter-point and tonality is equally loose.

In the next part comes the statement "it is surprising how often savages sing in the minor key" (p. 145); then various instances are noted of minor music though the ideas are merry and vivacious. "This occurrence of minor chords in savage music is no doubt of the greatest importance and will have to be taken into consideration in further researches on the physiology and psychology of music. * * * It is questionable whether savages notice any peculiar difference." As historically our minor came late into use, "we may connect with it the idea of the unusual, and may use it on occasions when something extraordinary is intended" (p. 149)! There is no need of quoting more, for the author knocks the foundation out from under his philosophical structure when he says, "it is also the uncertainty of intonation and the constant fluctuation of the voice which give us the impression of the minor key rather than of the major." One might as well say that the uncertainty of articulation of a savage speaking in his own tongue gives the impression of say cockney English, rather than English as spoken in Boston. Later we shall return to this matter of the interpretation of the sounds one hears.

The last part of Chapter IV., on the scale, is chiefly notable for the author's repeated assertion that the diatonic scale has been the constant basis in the development of music; for his clear-cut statement that the scale cannot be founded entirely on any natural properties of the ear or laws of the constitution of musical sound; and for his insistence on the instrumental origin of scales. The first of these three points is demonstrably inadequate and untrue; the others we believe to be true and important, though often ignored or denied.

In view of the great dearth of books covering this field it is but slight praise to call this decidedly the best one in the market. Some of its defects have already been pointed out; the author is from the nature of the case compelled to build with such materials as other men bring him; some are of excellent quality, some are rubbish; there is, therefore, unusual need for a careful critical treatment of them. But all students of the subject will welcome his collection of material, and the bibliography and many suggestive passages, though they will hardly be willing to cite his conclusions as authoritative.

IV.

Miss Fletcher's monograph is by far the fullest and most carefully-made collection of savage music of which we have any knowledge. Her discriminating remarks on the difficulties of observing and recording what was sung may be commended to those who, like the author of the preceding book, seem to think any statement of a traveller is good evidence, or that it is an easy matter to note down characteristic music. This collection is the fruit of ten years of study, including many years of life among the Omahas: it is therefore written from an intimate knowledge of the life of the people; throughout it impresses the reader with the feeling that it is a remarkably sympathetic work; that never did an author enter more fully into the thoughts and feelings of an alien race. For this is far more than a collection of carefully noted tunes, difficult and admirable as such a work would be; there are added the meaning of the song to the people who use it, and the circumstances in which it is used, so that the reader may appreciate it somewhat as the native does.

The melodies thus collected were put into the hands of the late Professor Fillmore for study. He sums up the results of a laborious and interesting investigation thus: "The deficiencies and defects of Indian music are, first, lack of sensuous beauty of tone-quality; second, uncertainty of intonation. * * * The merits of the Indian music consist, first, in an elaborate, well-developed rhythm; second, in fresh, original, clear, characteristic expression of the whole range of emotional experience of a primitive people. * * * The problems presented in the study of primitive music are two : 1. The problem of the origin and function of music ; 2. The problem of the psychological, physical and acoustic laws in accordance with which the musical phenomena have become what they are" (p. 74).

The most novel part of Professor Fillmore's work is that dealing with the question of harmony in savage music. It has long been customary to add a harmony to simple melodies of people who never use accompaniments; and as many as thirty years ago Carl Engel showed the great danger of distorting the meaning of a tune by this procedure. But the author takes an almost opposite position, and maintains it with vigor; he holds in substance that the meaning of these songs cannot truthfully be presented without harmonizing them; certainly their interest is greatly increased, as no one can doubt who has had the privilege of hearing them rendered by the authors of this book and their coadjutor Mr. La Flesche; so rendered, some of them are very fine and inspiring and moving. In adding the harmony Professor Fillmore has taken the unusual precaution of submitting every piece of music to native judgment, and out of several modes of harmonization has selected that one which pleased Indian hearers best. As a result of this long testing, he concludes that the matter of scales to which ordinarily so much attention is given, is entirely subordinate; that any peculiar scale can easily be accounted for on harmonic grounds; and that the tonality is to be decided "not alone from the tones actually employed in the song, but from considering what tone or tones need to be supplied in order to make a natural or satisfactory harmony" (p. 64). Above all he thinks he has proved the existence of a 'latent harmonic sense' unconsciously determining the choice of melody-tones, or as stated in another place, "It seems clear to me that the course of these melodies can be accounted for in no other way than on the assumption that the Indian possesses the same sense of a tonic chord and its attendant related harmonies that we do: although of course it is latent and never comes clearly forward into his consciousness" (p. 76). But in spite of this positiveness of conviction there is a suggestive doubt expressed in the last paragraph; "how the feeling for the tonic chord is generated in melodies which do not begin with the key-note, and especially in those which begin with a by-tone, as some of these songs do, I am as yet unable to conjecture" (p. 77).

These views of the joint authors have received hearty (though not universal) acceptance in musical circles, but ethnologists and other students of the problem of savage music dissent from them. To make clear the fundamental reason of this dissent, it will be necessary to go back and recall some things that the other books under review help to establish. To do this is important; for it is the reviewer's firm conviction that no one thing so hinders the intelligent study of non-European music as the wide prevalence of views similar to, though less clear and well developed, than those of which Mr. Fillmore is so able a defender.

And first it is to be recognized that all these authors have much in common, and, however divergent their outlooks, occupy substantially the standpoint of the modern European musician: so, collectively, they help to make more evident than a single book does just what this standpoint is. Klauser declares and Parry implies, as quotations from both have shown, that music is not a physical, but a psychological product, that most of its meaning anywhere is due to habituation, to long familiarity with the elements out of which it is built up; that it is conventional, in the same sense that spoken language is conventional. The listening musician is constantly trying to find the composer's meaning in a passage always imperfectly rendered; so he is being constantly trained to correct instinctively the sounds heard so as to fit them into his scale; then more or less consciously he notes the inter-relations of the sounds, the key and mode, modulations, rhythm, etc., for if these elementary things are obscure, the musical thought must be still more so; the case is closely parallel with the understanding of a spoken discourse. All this training and more is implied in the term 'musician.' Klauser's purpose is to promote such training and make the student conscious of it: Parry throughout implies that it is the basis of musical intelligence, and sometimes recognizes it rather explicitly: Wallaschek shows something of it: Fillmore and Miss Fletcher are saturated with it.

Now when a musician thus trained hears foreign music he cannot ordinarily help treating it in the familiar way, and assuming both that his notation is suitable, and that his familiar ideas are applicable. He reads into it his own notions and disregards what seems foreign to his established system. The students of savage and oriental languages have passed through and beyond this stage of development; so to-day the laity as well as scholars know that the utmost facility in and appreciation of one's mother tongue confer no ability to spell the words or understand the meaning of a foreign language; why then should a high musical training be thought *per se* to confer the ability to understand the music of a foreign race? We constantly hear that 'music is a universal language,' but the usual criticisms on foreign music or expressions of disgust with it show that the saying is substantially false, and that the words of a learned Chinaman to Amiot a century ago are far truer: "The airs," he said, "of our music go from the ear to the heart, and from the heart to the soul; we know them, we understand them; those that you play for us have not this effect." Fortunately a few writers have at least recognized that such terms as major and minor, modulation, tonality and harmony have very rarely, if ever, any applicability to foreign music; for instance, Mr. Parry does so in a passage in Grove's Dictionary, holding that these terms do not apply to anything inherent in this non-harmonic music, but only to the effects produced by it on hearers with European training.

It is just here, over the interpretation of the sounds heard, or the choice of a standpoint from which non-European music shall be judged, that the conflict is sharpest and most irreconcilable between professed musicians and the few scientific students of comparative music. Of the writers under review Parry has little and Klauser has nothing to indicate that there is a conflict, but they define admirably the advanced musician's standpoint; the others dealing exclusively with non-harmonic music should recognize the conflict and justify their choice of a standpoint if they would be accepted as authorities. But neither Wallaschek nor those from whom he quotes have, except rarely, made even the slightest attempt to find any other standpoint; while Fillmore repeatedly, triumphantly, and with italics declares that there is no other, saying for instance, "These melodic aberrations to which I have referred are easily and naturally accounted for by reference to their natural harmonic relations, *and in no other way*" (p. 61). His able paper is practically a challenge to every scientific student of musical problems; one must accept it and fight to victory in his own mind, or give up the contest for the application of scientific methods of research; for in effect it denies that the methods which have revolutionized the study of the history of religion, society, language and art, can be applied to music. Moreover, if Mr. Fillmore's presentation is correct it is hard to avoid the conclusion that the Omahas, though unconscious of it, are at the same stage of musical culture as he was; for he was just able to account for every peculiarity of their music, but only by bringing in "pretty much the whole ground of modern harmonic structure," including "the use of the third and sixth relationships in harmony, one of the most notable peculiarities of the Modern Romantic school" (p. 62). One cannot resist the suspicion that the writer has portrayed a cloud-land, not real hills lying as distant from his point of view as savagery is from civilization,—a suspicion strengthened by a multitude of facts, that there is no space here even to hint at.

But lest this criticism be misunderstood let us remind ourselves that in reporting music, as in writing history or producing a picture, there are two distinct ways of working; one aims either at a photographic, literal, scientific, analytical presentation, or at an artistic one; rarely at both. If the worker's aim be not regarded his most successful portraiture may be considered false; the artist disregards details, aiming rather at the impression of the whole; the scientific worker must first have the details. Miss Fletcher presented her "collection of Omaha Indian songs feeling confident that therein is truthfully set forth in a manner intelligible to members of my own race the Indian's mode of expressing emotion in musical forms" (p. 7): so her aim was artistic; she deliberately disregarded the material she had collected along the lines of physical or scientific presentation. She does not pretend to give the Indian music accurately as to pitch or quality, but in a translation, as it were, or perhaps rather a paraphrase. Many persons can deny that she gives Indian music; probably she is the most competent witness on the question whether her melodies with Mr. Fillmore's harmonies express to white musicians the emotions of the Omahas. No one doubts that for Miss Fletcher's purpose the modern musician's standpoint is the necessary one: is there any more doubt that for Mr. Fillmore's philosophical and scientific purpose it is absolutely unfit, and that views from it are obscure and misleading?

V.

While all such faithful, sympathetic attempts to paraphrase foreign music are cordially welcomed, we must not forget that an even harder work remains to be done:—to find out the elements of every strange musical language, and the rules by which they have been combined, and so to come to some real understanding of the thoughts and moods that lie back of the musical expression. In spite of the brilliant successes of the present generation in making vivid before us the life and thoughts of past generations, the story of the world's music has not yet been told; and the thousands of unsatisfying pages that attempt to do it still leave the subject in the condition of Egyptian history before the hieroglyphs were deciphered. The strong light thrown by the books under review on the position of modern European musicians shows that they are even farther removed from musicians of all other lands and times, than any one realized a few years ago. So before an author can write an adequate universal history of music, he must find, and occupy at least for a time, some other standpoint than that occupied by the writers of these books.

Charles K. Wead.

THE EFFECT OF THE MEXICAN EARTHQUAKE OF JANUARY 19, AT MOUNT HAMILTON, CALIFORNIA.

The detection of the occurrence of a distant earthquake shock, by means of a Meridian Circle, appears to be sufficiently novel to be worthy of record. The effect was noticed here, upon setting the telescope for the Nadir observation, on the night of Friday, January 19th, the date of the earthquake, most seriously felt at Colima, Mexico.

The reflected images of the threads were at once seen to be swinging across the field of vision, with a regular oscillation, much like the swing of a pendulum. The period was about seven seconds for the full amplitude of the swing. The extent of the arc could be exactly estimated, in the east and west direction, by the fixed transit threads, and appeared to be of the same amount in the north and south direction. The reflection from the surface of mercury doubles the actual angle of inclination, which was very closely 15″, for the full arc of vibration, at the maximum seen.

This corresponds to a total displacement of the eye end of the telescope of $\frac{1}{200}$ of an inch. A movement of twice this amount in the surface of the earth, when produced suddenly, will ordinarily be detected as a slight earthquake shock, and will be recorded by delicate seismographs. It would fall at II. of the Rossi-Forel scale, and is about as slight a vibration as can usually be detected. The delicacy of this test is shown by the fact of the oscillations being still easily perceptible when they had fallen to less than one-tenth of the above maximum.

It is probable that vibrations in the earth's crust of much larger extent would still be entirely imperceptible to the senses when taking place as slowly as in the present case. They are believed to extend to great distances from the active center of the disturbance, at least in special cases; and may perhaps precede the sensible shock by a considerable interval. In the additional instance, recorded below, there is little doubt that the early vibration was the forerunner of an earthquake shock, which was local only, as far as known.

In the present case, if the same vibrations extended to the summit of our large dome, they would amount to but the twentieth of an inch in actual displacement; and being of so slow a period, no injury would be anticipated. We have records here of displacements of the earth's crust during earthquake shocks of twenty times that of January 19th, coming as sharp and continued vibrations.

The oscillations were first noted at 10h. 50m. Pacific standard time, eight hours slow of Greenwich. Local time would be six minutes less. They continued of the same amplitude, apparently, for five minutes at least, and at 11h. 5m. had diminished to about one-quarter of the maximum. At 11h. 15m. they were still easily perceptible, but appeared no longer as uniform; the reflected image would appear stationary for several seconds and then continue the swing.

At 11h. 30m. the vibration had so nearly ceased that the Nadir observation was made, in order to determine whether any change had taken place in the position of the instrument. The comparisons with preceding and following determinations indicate no change in any particular. The swing was nearly as regular as a pendulum at the beginning, and there was little variation in successive swings, except as they diminished in intensity, just as a pendulum comes to rest.

The night was at that time nearly calm; the wind, which had been earlier light from the northwest, having died out. It should be added that the Nadir observation is usually easily made here. There are no shocks to be anticipated of any character at night, and the wind, even at 40 miles an hour, does not interrupt the reflection of the images. When coming in strong gusts there is no vibration at the surface, either coming from direct pressure or carried down by the walls of the building. The last will often quiver and rebound from the impact of the wind, as if it had been hurled against us in solid form. There is, of course, some difficulty in obtaining a steady illuminating flame during high winds, but no disturbance of the mercury surface.

The last previous observation of a star had been made upon a circumpolar at upper culmination, and nothing unusual was noticed up to the time of leaving the telescope. The last thread was taken nine minutes before the oscillation was detected at the Nadir, or at 10h. 41m. P. S. T. In the interval the circles and micrometer were read and the meteorological record taken for refraction. The barometer was again read, shortly following the cessation of the disturbance, and no change had taken place. The automatic recording instrument does not indicate any disturbance in the pressure during this interval.

The probable error of a telescope bisection is not greater than the hundredth part of the oscillation, at the maximum; so that it is clear that nothing of that nature was occurring at the time of observation. Nor could it fail to be detected in the transit record.

The circular reading, itself, might not indicate the beginning of the vibration; since it was of so slow and regular a character, that the telescope would probably have not been disturbed, in its position upon the pivots. An earthquake shock usually changes the position of the telescope in the wyes; in one case a change of 3″ was noted, as effect of a small, but perceptible tremor.

There is, thus, no way in which to fix the commencement of the oscillation, between the limits of 10 h. 41 m. and 10 h. 50 m. The duration is extraordinary, especially considering its minute amount. It was continuously observed for forty minutes. So impressive and startling was its character, when noted in an instrument of such stable form of mounting, that the observer had no hesitation in announcing the coming of an earthquake for this locality. Some previous experience served as the basis for such a prediction. On May 7, 1894, a similar oscillation, but far less pronounced in extent and duration, was detected by the same means. It was followed, after an interval of an hour and five minutes, by a slight earthquake, noted by three observers on Mt. Hamilton.*

In observing from two to three hundred nadirs a year, these two instances are the only ones noted of any vibration in the mountain. The indications were that this presaged a shock of a serious nature; and the chagrin, for an unfulfilled prophecy, is easily more than counterbalanced by the relief from the experience of a severe earthquake.

The connection with the Mexican earthquake is pretty clear, taking into account the slightly detailed accounts that have yet reached us. That was most severe at Colima, and Guadalajara, six or seven persons having been killed, many injured, and much damage to old and substantial buildings having been done. The first accounts of that disaster reached us on Monday, through the daily papers; and it appears that no further details are likely to be printed in that form. At Colima, the time was given at a quarter before twelve. At Guadalajara it was recorded at midnight. These cities are 18°, or a little more than an hour east of Mt. Hamilton: so that the first statement of the time would make the epoch near the beginning of the vibration noted here. Until more exact details of the times, recorded in Mexico, are known here, it will not be possible to check for closer agreement.

The cities where the worst of the shock

*Pub. Astr. Soc. Pac., 1894, Vol. VI., p. 184. Catalogue of Earthquakes, E. S. Holden: Smithsonian Miscell. Collec., No. 1087, p. 227.

was felt, are distant 1500 miles from this point. The shock would appear to have reached IX. of the R. F. scale, at the center. It will be interesting to learn how far this side the center, any sensations were noticed. The delicate indications of a fine telescope, poised over the mercury, will fill in the gap between the borders of the sensible shock, and the far extent of the real disturbance of the earth's crust.

R. H. TUCKER.

LICK OBSERVATORY, UNIVERSITY OF CALIFORNIA,
Jan. 24, 1900.

NOTE.—The thirty-six-inch and twelve-inch refractors and the Crossley reflector were in use while the oscillations of the earth, recorded by Professor Tucker, were taking place, but no unusual disturbances of these instruments were noticed. The observers were not, however, aware of the disturbance of the mercury under the meridian circle.

J. E. K.

THE CHICAGO SECTION OF THE AMERICAN MATHEMATICAL SOCIETY.

THE Section held its sixth semi-annual meeting at the University of Chicago on Thursday and Friday, December 28 and 29, 1899. Four sessions, two on each day, were fully occupied with the presentation and discussion of papers. Professor Moore, Vice-President of the Society, occupied the chair during the first session, after which Professor E. W. Davis presided.

The following papers were read:

(1) MR. R. E. MORITZ, University of Nebraska: 'A generalization of the process of differentiation.'

(2) PROFESSOR E. D. ROE, Elmira, N. Y.: 'On the transcendental form of the resultant.'

(3) DR. E. J. WILCZYNSKI, University of California: 'An application of Lie's theory to hydrodynamics.'

(4) DR. F. R. MOULTON, University of Chicago: (1) On the question of the stability of certain particular solutions of the problem of four bodies; (2) Particular solutions of the problem of n bodies of the Lagrangian type.

(5) PROFESSOR L. E. DICKSON, University of Texas: 'The canonical form of linear homogeneous substitutions in a general Galois field; (2) The cyclic sub-group of the simple group of linear fractional substitutions of determinant unity in two non-homogeneous variables with coefficients in an arbitrary Galois field.

(6) DR. J. V. WESTFALL, University of Iowa: 'On a category of transformation groups in space of four dimensions.'

(7) PROFESSOR O. BOLZA, University of Chicago: 'The elliptic sigma-functions considered as a special case of the hyperelliptic sigma-functions.

(8) PROFESSOR ALEXANDER PELL, University of South Dakota: Calculation of the integral

$$\int e^{-\left(px^2+\frac{q}{x^2}\right)} \begin{matrix}\sin\\ \cos\end{matrix} \left\{rx^2+\frac{s}{x^2}\right\} dx.$$

(6) PROFESSOR JOHN A. MILLER, Indiana University: 'Concerning certain elliptic modular functions of square rank.'

(10) PROFESSOR ROBERT J. ALEY, Indiana University: 'A new collinear set of three points connected with the triangle.'

(11) PROFESSOR H. MASCHKE, University of Chicago: 'Note on the unilateral surface of Moebius.'

(12) PROFESSOR C. A. WALDO, Purdue University: 'On a family of warped surfaces connected by a simple functional relation.'

(13) PROFESSOR HENRY S. WHITE, Northwestern University: 'Plane cubics and irrational covariant cubics.'

After the papers listed above had been read there followed a general discussion on the topic 'Limits of function of one or more variables' introduced by Professor Moore.

The program committee for the following year was elected at this meeting and will consist of the Secretary *ex-officio*, Professor H. B. Newson, University of Kansas, and Professor C. A. Waldo, Purdue University.

The next meeting of the Section will be held on Saturday, April 14, 1900, at Northwestern University, Evanston.

THOMAS F. HOLGATE,
Secretary of the Section.

EVANSTON, ILLINOIS.
Jan. 6, 1900.

*CORDILLERAN SECTION OF THE GEOLOGICAL SOCIETY OF AMERICA.**

A YEAR ago, as has been already reported in SCIENCE, about a dozen west coast geologists met at Berkeley and organized the Cordilleran Geological Club. The organization was at once recognized as temporary, and the project of organizing permanently as a Section of the Geological Society of America formed a leading topic of discussion at the meeting. The following spring a number of fellows of the Society resident in California memorialized the Council of the Society, setting forth their inability to be present at the meeting of the Society owing to the great distance at which they reside from the usual places of meeting, and praying for legislation on the part of the Society which would enable them to meet as a geographically distinct Section of the Society. The Section was formally recognized by the Society at its Washington meeting, and the Council of the Society was authorized to frame rules governing the Section in its relations to the main Society.

The meeting of the Cordilleran Section was very successful, and it is clear that its organization will greatly strengthen the Society in the West. Provisionally Professor Joseph Le Conte was elected Chairman, Andrew C. Lawson, Secretary, and Professor J. E. Talmage, Councilor, the three to constitute an executive committee.

The following papers were presented :

The discovery of a goat antelope in the cave fauna of Pike's Peak region. By F. W. CRAGIN, Colorado Springs, Colo.

In having the cave-earth removed from a cave in the Manitou limestone of his Glen Eyrie estate a few years since, General W. J. Palmer saved organic remains, consisting of a number of bones, and submitted them to the writer for determination. Two of the specimens belonged to a slender-limbed horse of the late Pliocene or Quaternary age. Other remains belong to a species of woodchuck, probably different from any now living in North America. A humerus and cannion bone of a two-toed ungulate were found to differ from the corresponding bones of all the artiodactyles now living in North America, but agreed closely with those of the Capricorn or Goat-Antelope (*Nemorhœdus*) of the Himalayan region. In recognition of General Palmer's liberal patronage of science the species is named *N. palmeri*.

The finding of goat antelopes in the extinct fauna of the Rocky Mountains, though unexpected, is no more remarkable than the occurrence of elephants, which are also of Oriental origin.

On the occurrence of ground-sloths in the Quaternary of Middle California. By JOHN C. MERRIAM, Berkeley.

The remains of two ground-sloths have recently been obtained from Middle Californian deposits of unquestioned Quaternary age. The first specimens found consisted of large humerus fragments obtained by Judge Jones, of Martinez, Calif., on the south shore of Suisun Bay. Associated with them were remains of *Elephas* and a large species of *Equus*. During the past year, 1899, Mr. A. Huff obtained a large and perfectly preserved humerus from loose, horizontally stratified deposits on the eastern shore of Tomales Bay, in Marin County, Calif. An *Elephas* tooth seems to have been obtained from the same deposit.

The specimens from the two localities seem to belong to the same or closely related species. This form fits most satisfactorily into Marsh's genus *Morotherium*, which was described from material obtained in Alameda County, Calif.

Classification of the John Day beds. By JOHN C. MERRIAM, Berkeley.

The John Day beds average about fif-

* First annual meeting, San Francisco, Calif., December 29 and 30, 1899.

teen hundred feet in thickness, and apparently contain a very large proportion of volcanic materials. They seem to rest unconformably on a thick series of plant bearing, fresh water beds, which have been considered Eocene. The Columbian lavas rest apparently unconformably upon the John Day beds.

On the basis of lithologic and stratigraphic characters, the John Day System may be divided into three divisions, lower, middle, and upper John Day. The lower beds are mainly colored a brilliant red, seem to have suffered more disturbance than the higher beds and are practically barren of fossils. The middle beds are blue, green or drab, and are in in places quite fossiliferous. The upper beds are bluff or white. They are largely made up of volcanic material. Many fossils have been obtained from this division. One horizon particularly is rich in rodent remains.

The writer's study of the vertical range of the John Day species has not progressed far enough to permit of any definite statement regarding their zonal arrangement. Professor J. L. Wortman has already proposed the division of the system, on faünal grounds, into upper *Merycochaerüs* and lower *Diceratheriüm* beds. The use of the lithologic divisions here proposed will greatly aid in the study of the vertical range or history of John Day species.

Notes concerning erosion forms and exposures in the deserts of South Central Utah. By J. E. TALMAGE, Salt Lake City, Utah.

A description of the effects of denudation in the region lying east and south of the Thousand Lake Mountain, and west of the water pocket fold. The dissection of the Trias and Jura was illustrated by numerous photographs. In the work of rock disintegration much importance was attached to the great diurnal range of temperature, the range being 80° to 85° F. during the autumn months. Dykes and hills are prominently exposed in certain parts of the region. Selenite geodes similar to that first reported in SCIENCE, February 17, 1893, are of frequent occurrence.

On certain peculiar markings on sandstones from the vicinity of Elen Cañon, Arizona. By J. E. TALMAGE, Salt Lake City, Utah.

The paper was illustrated by photographs and slabs of the rock. The markings appear as right lines with approximately rectangular intersections; the lines are shallow troughs from .5 mm. to 2 mm. in width though occasionally in coarser rocks they are as much as 9 mm. wide and 3 mm. deep. The rectangles have an average size of about 4x6 mm. Unbroken lines of 395 cm. have been traced. The rock is a fine-formed argillaceous sandstone of brick red to chocolate color. It occurs as a bed two feet thick between coarser sandstones. Ripple marks, rain drop impressions and sun cracks appear in the marked rock.

Attempts to reproduce the right line markings were described, leading to the conclusion that the lines are perhaps the result of crystalline cleavages in saline cakes deposited through desiccation. Pinate impressions suggesting frost flower pictures occur with the right line markings and these were reproduced experimentally. Slabs of the stone $2\frac{1}{2}$ square yards in size and completely covered with the right lines were taken from the deposit.

Conglomerate 'puddings' from the Paria River, Utah. By J. E. TALMAGE, Salt Lake City, Utah.

The paper was an explanation of photographs, showing a number of fresh conglomerate masses, consisting of pebbles and mud formed by accretion through rolling. The formation of these puddings was observed on the mud flats of the Paria. The sticky mud and river, worn pebbles readily cohere, and by rolling the lumps, increase in size and were found ranging in size from three inches to two feet in diameter. When left to dry they fall to pieces. Some were observed partly buried in the mud; and it is probable that many have been covered up by flood deposits.

Thomsonite and other zeolites from Golden, Colorado. By HORACE B. PATTON, Golden, Colo.

The points of interest are remarkably beautiful and delicate masses of Thomsonite recently found, and the extraordinary variety in habit of this material in the same and closely adjacent cavities. The paper was accompanied by photographs.

The peneplain question upon the Pacific Coast. By H. W. FAIRBANKS, Berkeley, Calif.

A topographic study of the islands of Southern California. By W. S. TANGIER SMITH, Berkeley, Calif. Presented by Andrew C. Lawson.

The islands are classified according to their general physiographic features, and the main reasons for the pronounced differences found are given. The physiography of each island is then considered in some detail, and a general description of the submarine features of the coast of California (particularly in the south) is also given. This is followed by a consideration of the chief conditions governing the formation and preservation of terraces and other wave-formed features. Finally, the most recent movements of the coast are considered, with the conclusion that the islands have moved in unison with the mainland.

An early geological excursion. By JOSEPH LE CONTE, Berkeley, Calif.

An informal narrative of a camping trip in 1844 to Lake Superior, thence up the St. Louis river, thence by portage into the upper tributaries of the Mississippi, thence down that river to Fort Snelling, thence by steamer to Galena, St. Louis, and Pittsburg, and finally by rail back to New York. The paper was of interest chiefly from a historical point of view. For example: The writer went to Lake Superior with the first mining party (Colonel Gratiot's) that opened the Lake Superior copper mines and camped with the party for three weeks at Eagle Harbor. After leaving Eagle Harbor on a canoe trip of about 800 miles, only three or four white men were seen. The canoe was drawn up on the very spots where Duluth and Minneapolis now stand, but many years before those cities existed. Many important geological observations were made and recorded for the first time, but the writer was too young to appreciate their full significance.

Some coast migrations, Southern California. By BAILEY WILLIS, Washington, D. C.

The sequence of events discussed in the paper includes (1) the development of the Santa Lucia series; (2) erosion of the Santa Lucia series; (3) deposition of the Franciscan conglomerate, sandstone and shale; (4) orogenic movements which resulted in profound deformation of the Franciscan formations; (5) deep erosion of the Santa Lucia and Franciscan rocks, which is partly represented in later sediments; (6) evolution of the present mountain system and coastal front. The paper presents observations made during a trip from Monterey to San Luis Obispo along the intervening coast ranges. The writer was accompanied by Dr. H. W. Fairbanks, in whose articles many of the facts presented have already been published.

The sandstone reefs of Brazil. By J. C. BRANNER, Stanford University.

The geological significance of soil study. By E. W. HILGARD, Berkeley, Calif.

This paper discusses, first, the importance and convenience of observations on soil areas and their characteristic vegetation, in the delineation of geological formations. It then treats of the chemico-geological relations between the latest geological formations, soils, and the more ancient deposits which, after emergence, have been subject to subaërial agencies.

The American Devonian placoderms. By E. W. Claypole, Pasadena, Calif.

Following a detailed discussion of the structure and relationships of the principal Devonian genera of North American placoderms, the author presented his views on the habits, habitat, origin and migrations of the great armor-clad forms.

The Berkeley Hills—a detail of Coast Range geology. By Andrew C. Lawson, Berkeley, Calif.

A discussion of the geological history and structure of the hills in the vicinity of Berkeley, accompanied by a colored map on a scale of 1 : 12,000 and six geological sections.

Andrew C. Lawson,
Secretary.

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*PROFESSOR HENRY ALLEN HAZEN.**

By a sad accident on the evening of Monday, January 22d, the Weather Bureau lost one of its most prominent officials. Professor Henry Allen Hazen, while riding rapidly on his bicycle, hastening to his night work at the Weather Bureau, collided with a pedestrian and was dashed to the ground. After lying unconscious for twenty-four hours, he expired on the 23d. His body is interred in the family burying-ground at Deerfield, Massachusetts.

Professor Hazen was born, January 12, 1849, in Sirur, India (about 100 miles east of Bombay), the son of Reverend Allen Hazen, a missionary of the Congregational Church. He came to this country when ten years old and was educated at St. Johnsbury, Vermont, and at Dartmouth College, where he was graduated in 1871. After this, he removed to New Haven and was for four years instructor in drawing in the Sheffield Scientific School, and for four years subsequent was assistant in meteorology and physics under Professor Elias Loomis. He was also privately associated with the latter in meteorological researches and the preparation of many of the 'Contributions to Meteorology,' published by Professor Loomis, some of which bear evidence of the reflex influence of the student on the master.

In the spring of 1881, when the present writer first saw Professor Hazen in New Haven, the latter showed such an earnest interest in meteorology as to justify recommending him to the position of computer in the 'Study Room' which was then being organized by General William B. Hazen the Chief Signal Officer, for the purpose of developing the scientific work of the Bureau, as a necessary adjunct to its important practical work. After his entry (May, 1881) into the meteorological work of the Signal Service, Professor Hazen took a prominent part in this field. The special works assigned to him (such as the deduction of altitude by railroad levels, the study of the psychrometer, the proper exposure of thermometers, the study of thunderstorms, annual courses of lectures on meteorology), were by no means sufficient to absorb his energies, and we find him branching off into many other subjects, such as barometric hypsometry and the reduction to sea-level, the testing of anemometers, the study of tornadoes and the theories of cyclones, atmospheric electricity, balloon ascensions, the influences of sunspots and the moon, the danger lines of river floods, the sky glows and the eruption of Krakatoa. His enthusiastic advocacy of the importance of the balloon to meteorology was very highly appreciated. His five ascensions (1886, June 24, 25; 1887, June 17 and August 13; 1892, October 27), undoubtedly gave very accurate temperatures and humidities.

* From advance sheets of the *Monthly Weather Review.*

After the death of General Hazen and during the administration of General Greely, the computers of the Study Room became junior professors at a higher salary and were assigned to official duties of a broader aspect. In the course of such duties, Professor Hazen frequently took his turn as forecast official (beginning with October, 1887), and as editor of the *Monthly Weather Review* (beginning with December, 1888), while also acting as assistant in the Records Division. In July, 1891, in accordance with the terms of the transfer to the Department of Agriculture, he was appointed one of the professors of meteorology in the Weather Bureau, where he was at once assigned to regular and congenial duties in the Forecast Division.

Having shown that 'the Hazen thermometer shelter' was much better than the large close double louver formerly used, his form was adopted by the Bureau in 1885 and still remains in use. His experimental work with the sling psychrometer and dew-point apparatus was executed with great care and refinement, but the resulting psychrometer formula differs from those in current use in that it rejects the important term depending on the barometric pressure. Among his larger publications were: *The Reduction of Air Pressure to Sea-level* and *The Climate of Chicago*.

In addition to his official work in the Weather Bureau, Professor Hazen was a frequent contributor to meteorological and other scientific journals. He was one of the supporters of SCIENCE during the years 1882–89 and of *The American Meteorological Journal*, 1884–96. He also, published independently his 'Meteorological Tables,' and 'The Tornado,' and possibly other works. A complete list of his published writings would include several hundred titles.

It must be confessed that a peculiar temperament sometime led him to beliefs and statements in scientific matters unacceptable to his colleagues, but to which he adhered and on which he acted with such pertinacity that to some he occasionally appeared obstinate and headstrong; this was simply a result of the intense earnestness of his own convictions, which so completely absorbed his mind that there was no place for further considerations. However, the amiability of his character always prevented any enduring unpleasant feeling between himself and his associates.

C. A.

SCIENTIFIC BOOKS.

Annual Report of the Bureau of Steam Engineering of the Navy Department; 1899. Washington, Government Printing Office. 1899. Pp. 89. Many illustrations and working drawings.

The annual report of the Chief of the Bureau of Steam Engineering of the Navy Department, made up in advance of the compilation of the annual message of the President and reports of the heads of department for the information of Congress and the people of the United States, always contains interesting matter bearing upon applied science, although mainly devoted to the purely technical side of the work of that bureau. Admiral Melville is equally positive, direct and effective, whether at the Lena Delta seeking lost heroes, or in his office at Washington, and his report illustrates his character as well as his work. Passing over the purely technical accounts of the condition of the mechanisms of the naval war-engine, and of the fleets, the first subject of general interest is that of the recent consolidation of the two great corps, the engineer and the line officers, as effected by the 'personnel bill' of last year. Without explicit assertion of the fact, it may fairly be inferred, we think, that the Chief of Bureau is apprehensive lest the terms of the bill and its purpose may fail of complete accomplishment, the Department lacking that firmness and determination to obey and to make successful the conclusions of Congress regarding this important experiment. It is obviously an experiment and is no less obvious that it may be made to succeed or to fail, accordingly as the officers of the Government, from the President and the Secretary of the Navy down to lieutenant and ensign, combine to insure its success or conspire to insure a failure. It will only be when every watch-officer, whatever his grade, is made an efficient officer, both above and below decks, that the modern naval fighting machine can be made of maximum efficiency under the existing system. Any disinclination of either of the old types of officer to become efficient in either old line of duty, results in serious, perhaps very dangerous, inefficiency, and a liability to failure at critical times. The conversion of the navy from a sailing to a steaming fleet, from an aggregation of sailing craft into a collection of floating machines of wonderfully complicated mechanism, cannot be reversed; but the change may prove most disastrous during the period of transition if every officer in the service does not display sufficient patriotism to insure rapid and safe metamorphosis. It is here that the real risk lies and the overcoming of confirmed habits, of prejudice, and any indolence of the personnel, by reason, sense and patriotism, must be relied upon to insure success.

The structural work of the navy has been greatly promoted by the introduction of a new structural material—nickel-steel; which alloy is now regularly furnished in any quantity and in parts of any size, from five pounds in a rifle-barrel to many tons in the shaft of a transatlantic or Naval steamer. This is an alloy of 'mild' steel, ingot-iron, with a small percentage of nickel, resulting in greatly increasing the limit of elasticity and the ultimate resistance of the metal, without sacrificing its ductility.

Electrically driven machinery has come to be an important and very extensive element in the construction and installation of details of the machinery of every man-of-war. The advantages, where allowable or applicable, are great ease of operation, convenience of energy-transmission, and especially avoidance of heat due to the transmission of steam to steam-driven machinery about the ship, and a considerable gain in economy, in many cases. The disadvantages are stated to be excessive weight, great delicacy, lack of adaptability to the conditions of everyday work at sea, and the occupation of spaces below the protective deck, where space is particularly valuable and difficult to secure for the apparatus of battle. The admiral thinks the advantages of electrical transmissions on shipboard somewhat exaggerated and that, within the machinery compartments, at least, 'steam-drives' are preferable. He refers to the curious fact that, in the navy, it has been the custom, very generally, to entrust the machinery of the electric transmissions to the non-expert departments of the organization. The experts in engineering are apparently called in only when the responsible amateur gets into trouble. As the presumably best-informed man in the navy, on this subject, the Engineer-in-Chief is entitled to most respectful consideration and a full hearing, when discussing these matters of fact and principle in engineering.

The transformation in type of the marine steam-boiler, from the older forms to the 'modern', 'sectional,' 'safety' or water-tube type, appears, in the judgment of the responsible expert authority of the navy, to have been practically accomplished—a change which was compelled as soon as the steam-pressures needed to insure the now common and high thermodynamic efficiencies of naval steam-engines had attained figures beyond the safe standards for 'shell' boilers of the old forms. Now that steam pressure is carried at from 15 to 20 atmospheres, the safer forms employed by Fulton and Barlow in 1798, by John Stevens 1804–5, by Trevithick in 1810, by Gurney and Hancock in 1830–35, and by them made successful in earlier generations and by Babcock and Wilcox and Root later, have come permanently into use. It is somewhat remarkable that they should have been first accepted so generally in the navy, where it has been a tradition that the traditional is best. The change is perhaps in part due to the introduction of a progressive spirit with steam, and certainly largely through the appearance on the scene of the young element now coming up from the great technical and professional school at Annapolis, where it has become imbued with the scientific spirit of the time.

R. H. T.

Bacteriology applied to the Canning and Preserving of Food Products. By EDWARD W. DUCKWALL. Baltimore, *The Trade.* 1899. Pp. xi + 111. 17 colored plates. 7 figures in text. Price, $5.00.

There is great need of a good manual of bacteriology in its applications to the food-preserving industries. The arts of refrigeration and sterilizing have probably done nearly as much as has improved transportation towards abating that unfortunate state of affairs described by Macaulay in which, owing to bad roads, it was no uncommon thing in England, in the seventeenth century, for the fruits of the earth to rot in one place, when only a score of miles away people were suffering from a scarcity of the very food which was spoiling almost within their reach. The author of this 'Bacteriology' is to be commended, therefore, for his recognition of this need and for his evident desire to meet it. The announcement of the work, however, aroused apprehension when it stated that "After some unavoidably long delays, due to the nature of the work which of necessity must be minutely correct and exact * * * the book you have been waiting for * * * is now ready * * * This work, handsomely bound in leather, and printed on heavy paper, contains 24 microscopical views of the living germs found in canned goods in their *natural color*, and just as they appear to the eye under the cover glass. The whole work is written with the express purpose of enlightening and teaching canned-goods packers and preservers of food-products the highest and most scientific method of handling all kinds of foods." It was not encouraging to be thus informed that we were to see 'views of the living germs * * * in their natural color,' and the appearance of the work itself has not been reassuring. A careful examination leads to the conclusion that it has been hastily and even carelessly prepared ; that it is full of errors both of substance and form ; and that the author, while enthusiastic in his appreciation of the importance of bacteriology to his favorite industries, is not himself a trained bacteriologist, but only an amateur filled with zeal rather than knowledge. If, as stated in the announcement, "the whole work is written with the express purpose of enlightening and teaching," it must be frankly said that it is not a success, and that there is danger that it shall darken rather than illuminate understanding among those for whom it was prepared. A few citations will suffice.

In describing certain microscopic observations upon sour tomatoes, the author says on page 2 : "I found quite a number of small round globules, which at that time I was unable to understand. They seemed to be motionless, except a slight quivering which is termed Brownian motion. There were small rods and little fine dots sometimes alone, sometimes in pairs, and looked like ants. There were also small forms barely perceptible and one or two specimens of a very large germ. The view given in the accompanying plate is just as it was taken." The 'view' referred to shows some yeast-like bodies, bacilli and spherules, but the yeast cell walls are colored blue, and the contents of the yeast cells are a mixture of blue dots and red lines. Passing over a multitude of ill-digested and more or less muddy statements, drawn apparently from various authors, but rarely quoted with precision and seldom if ever attributed to the proper source, we may notice one of the more surprising statements in regard to the physiology of bacteria (p. 13) : "Sometimes an acid is generated which will kill them, and that acid may be due to their own action. The condition will become favorable, too, when the organisms have performed their work." Of the butyric acid bacteria the author says (p. 20) : "They are so small in this dried-up form that we can almost conceive of them being able to pass through the juice without becoming wet." And again, on p. 39, " * * * the flavor which is imparted to the beer and wine and the peculiar flavor of cheese and butter we know is due to the products of the butyric ferment, amylobacter." The serious blunder made in this statement appears in another place (p. 7) : "The butyric ferment * * * is so useful in ripening cheese and making butter that this form is cultivated and employed in some of the best creameries."

In regard to Bacillus prodigiosus we find some equally astounding statements (p. 23) : "This is the organism which gives the odor of herring brine or fish to putrefying substances, and is also named 'bleeding bread' because it is a pigment bearing bacillus of red color, and forms spots when growing on bread, potatoes and onion that resemble blood. It is an egg-shaped germ about 1/25000 of an inch in diameter, which is very small * * *. This organism is very common * * *. The drawing here represented was taken from life * * *. [It] is also a germ causing unsoundness in bread and bakers have to guard their dough against this action to prevent souring * * *." The plate which occupies the page opposite this remarkable description is something wonderful to behold. Within a large ten-sided polygon indicated by a thin blue line we have a dozen or more of what appear to be long, stout bacilli or hyphæ, also blue, but showing a reticulum, or chromatin-like substance, of a bright red color. The main background of the field is nearly filled with small, oval, red-colored dots or circles, and besides these there are present n large numbers thin and almost invisible bluei lines which seem to be intended for delicate and very slender bacilli. The legend beneath reads: "Figure 13 Magnified × 1000. One part bouillon, 99 parts water. Rank putrefaction. Bouillon, prodigiosi." The whole effect of this plate must be seen to be appreciated.

Woodhead's excellent book on 'Bacteria and their Products' seems to have been the author's principal source of information, and if he had only quoted correctly, and copied Woodhead's figures with accuracy, there would have been little occasion for the present criticism. One of his worst blunders—to call it by no stronger term—is that in which the author gives as his 'Figure 19. Magnified × 1000. Kleles Loeffler Bacilli, × 1000,' a figure which so far as a careful comparison can determine is a copy of Woodhead's figure not of diphtheria, but of *anthrax* bacilli, and this, too, turned upside down. After discoveries of this sort the intelligent reader may be pardoned for regarding, with a certain cynicism, a rhapsody like the following (p. 31): "What a study it is, then, this science of bacteriology. It opens up a new world to us (*sic*) and we are permitted to gaze upon it and behold the scheme of Nature giving us object lessons day by day in the tearing down and building up process. Life begetting new life and new life flourishes on the dead; seed developing into form, form producing seed, decay of form, and development of seed. This is true of the germ and also of every living thing." As we peruse this strange deliverance we are compelled to agree with the author that form, here at least, readily goes to seed and even to rot.

It would be easy to extend the present review, but the whole work comes dangerously near to a burlesque of bacteriology and extended comment is unnecessary. Only one point more need be made. The author evidently quotes extensively from various writers and investigators without giving them credit. For the most part these statements have long since become the common property of bacteriologists, but toward the end of the book he apparently uses freely the recent and important monographs of Messrs. Prescott and Underwood, of the Massachusetts Institute of Technology, on the history of the canning industry and on bacteriological investigations of canned foods, especially of sour corn, of which a preliminary account was published in SCIENCE, Nov. 26, 1897, and yet never once mentions these authors.

We are tempted to close with the familiar warning that a little knowledge is a dangerous thing, and a reminder to those into whose hands the book may fall that blind leaders of the blind are apt to be untrustworthy. The author himself, in discussing the vacuum which exists in most well prepared and hermetically sealed food-cans, has, however, given utterance to a similar warning, in quite original metaphor: "We thus see that packers who are pinning their faith to a vacuum are depending upon a broken reed." Those who pin their faith to the author's kind of bacteriology will, we fear, discover to their cost that they are leaning not even upon a broken reed, but only upon a vacuum.

BOOKS RECEIVED.

Lehrbuch der Botanik für Hochschulen. EDUARD SRASBURGER, FRITZ NOLL, HEINRICH SCHENCK, A. F. W. SCHIMPER. Jena, Fischer, 1900. Fourth revised edition. Pp. viii + 588. 7 Mark, 50 Pf.

The Nature and Work of Plants. DANIEL TREMBLY MACDOUGAL. New York and London, The Macmillan Company. 1900. Pp. xvii + 218. 80 cts.

A Manual of Zoology. C. JEFFREY PARKER and WILLIAM A. HASWELL. New York and London, The Macmillan Company. 1900. Pp. xxv + 563. $1.60.

Optical Activity and Chemical Composition. H. LANDOLT, translated by JOHN McCRAE. London, Whittaker & Co.; New York, The Macmillan Company. 1899. Pp. ix + 158.

The Refraction of the Eye. A. EDWARD DAVIS. New York and London, The Macmillan Company. 1900. Pp. xii + 431. $3.00

SCIENTIFIC JOURNALS AND ARTICLES.

The Osprey for January begins with a paper by Paul Bartsch on 'Birds of the Road,' which is followed by an illustrated article on 'Esthetic Birds; The Bower Birds of Australia and New Guinea,' by Theodore Gill. Under the title, 'The Birds of the Hawaiian Islands,' Leonhard Stejneger reviews Scott Wilson and Evans' monograph of the Hawaiian birds and discusses some of the many interesting points connected with the avifauna of the islands. Charles E. Beecher contributes a sketch of 'Othniel Charles Marsh as an Ornithologist,' and gives a list of the fossil species described by him. The editorials contain some interesting statements as do also the notes.

Bird Lore for February opens with a brief, but appreciative biographical sketch of the late Dr. Coues, accompanied by an excellent portrait. Frederic A. Lucas contributes an illustrated article, 'Concerning Birds' Tongues,' and Frank M. Chapman has a 'Note on the Economic Value of Gulls,' which includes a very beautiful picture of a group of kittiwakes. A list is given of '*Bird Lore's* Advisory Council,' whose members have consented to assist students by responding to their requests for information. Lynds Jones discourses 'On Methods in Teaching Ornithology at Oberlin College' and W. H. C. Pynchon has a paper on 'Every-Day Study of Birds for Busy People.' Morgan St. John (aged 12) has an article on 'February Birds,' which shows that good observations may be made by a young observer. There are numerous notes and book reviews, and in the editorial department the question of bird protection is discussed at length.

The Plant World commences its third year with the January number and announces that a series of articles by Mr. Pollard on the families of flowering plants will appear as supplements to each number. C. F. Saunders describes the 'New Jersey Pine Barrens in July,' Wm. T. Davis has some 'Observations on a Woodland Fire,' and C. A. Crandall under the caption 'The Fall Green Orchis (*Habenaria hyperborea*) visited by Mosquitoes' tells how these insects assist in the pollination of this plant. V. K. Chestnut discusses a 'Fatal Case of Amanita Poisoning' and Mrs. Caroline A. Creevy continues the series of articles on 'Plant Juices and their Commercial Values.'

McClure's Magazine for October contained a short story entitled 'The Killing of the Mammoth,' which was taken by many readers, not as fiction, but as a contribution to natural history. Numerous requests for information have been received by the Smithsonian Institution and the editors of the magazine. To explain matters, the editors have inserted in the issue for February an interesting and excellently illustrated article by Mr. F. A. Lucas of the U. S. National Museum, entitled 'The Truth about the Mammoth.'

SOCIETIES AND ACADEMIES.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

THE 511th meeting of the Society was held at 8 p. m., on January 20th at the Cosmos Club, Surgeon General Sternberg, presiding.

Under the head of Informal Communications Professor T. J. J. See of the Naval Observatory, presented the results of his researches on the orbits of the Double-Stars τ Cygni and 95 Ceti. The substance of the paper was as follows: No good orbit of either star has been determined by previous investigators. The period of τ Cygni was found to be 57 years, and the eccentricity 0.37. The companion, which is always very difficult, has passed through periastion, and is slowly becoming easier to observe. 95 Ceti is the most difficult of known Double-Stars, and only a few measures have been made by previous observers. So many unsuccessful attempts had been made by Burnham and others during the last twenty years to separate the small star, that some astronomers had reached the conclusion that the system is in very rapid motion, with a period of perhaps less than ten years. But the recent measure secured by Professor See with the great Equatorial of the Naval Observatory, combined with others taken by him with the Lowell telescope in Arizona in 1897, show that the System in fact revolves slowly with a period of about 150 years. The present position-angle is 157°, and the distance 0.33. As the components are of the 6th and 11th magnitudes, the difficulty of the investigation is apparent. This star has not before been seen at Washington, and Professor See's success in observing it led him to think the seeing here is occasionally very good indeed. As the companion of 95 Ceti will remain at a constant distance for about 20 years it forms a test object for telescopes which will prove a useful criterion for observers.

The first regular paper was by Dr. Hyvernat, Professor at the Catholic University of America, who made a tour last summer in Syria for the purpose of ascertaining the cause of the perennial fountains so numerous in the Middle Region, or Wusut, of the Lebanon System. Special attention was given to the Province of Kesrawan which he explored from west to east, following the Nahr-el-Kelb and its chief tributary, the Nahr-el-Zalib, until he arrived at the Sannin Group. He discovered that the juncture of the main with the side-ridge, which runs in a northwesterly direction between the basin of the Nahr-el-Kelb and that of the Nahr-Ibrahine, forms a table-land sloping towards the north-west and studded with gigantic, rocky knobs. Between these knobs are numerous holes in the shape of craters, or funnels, filled with snow. Finding these holes entirely without outlet on the sides and without an exception, free from water, Dr. Hyvernat came to the conclusion that as the snow melts, the water filters immediately through fissures in the underlying rock and appears again at the foot of the High-Mountain, or Jurd, in the form of the aforementioned fountains. This to him seemed a better solution of the question of the origin of the fountains, than the theory of the condensed vapors, put forth by many geographers. Completing his own observations from those of E. H. Palmer and R. F. Burton, the lecturer remarked that Mount-Lebanon offered very likely the most extensive system of perennial fountains fed by 'snow-swallowing' holes. Dr. Hyvernat showed quite a number of specimens of geology, particularly from the lower cretaceous and the Nubian sandstone.

The second paper was by Mr. Mitchell Carroll on 'Recent Excavations in the Roman Forum.' Mr. Carroll said that the excavations in the Roman Forum, conducted during the past year under the direction of Signor Guido Bacelli, Minister of Public Instruction, and with Signor Giacomo Boni as superintendent, have shown gratifying results, especially in three directions: First, in the removal of mediæval and modern accumulations from certain ancient structures, and in the collecting and classification of the architectural fragments scattered about in the Forum; second, in the reconstruction of the temple of Vesta and *Ædicula* adjacent to it, and of a number of the honorary columns, whose pedestals front the Basilica Julia; and third, in the excavation of the area of the Comitium bordering on the Forum which has led to the discovery of what purports to be relics of the period of the Kings. These are: the 'Niger Lapis,' popularity designated the 'Tomb of King Romulus'; archaic votive offerings, (such as a terra-cotta tablet, bronze figurines, etc.); and above all in importance, a stelé, bearing an archaic inscription, supposed to date from about the middle of the seventh century, B. C. The lecture was illustrated by lantern slides showing the progress of the work.

E. D. Preston,
Secretary.

GEOLOGICAL SOCIETY OF WASHINGTON.

The 96th regular meeting was held at the Cosmos Club, January 24, 1900.

The following papers were presented on the regular program.

(1) Mr. C. W. Hayes: 'Solution Sinks in a Quartzite Formation.'

Two circular depressions, 150 feet in depth, occur on the southern flanks of Coldwater Mountain in Alabama. These depressions have all the characteristics of solution sinks. The rocks in which they occur are lower Cambrian quartzites and sandstones, the upper beds of the Weisner formation, which has a thickness of several thousand feet. The explanation offered for these sinks is that the beds in which they occur have been faulted over beds of limestone, and the material which originally occupied the depressions has fallen into underground channels through which it was carried off by flowing water.

(2) Mr. J. E. Spurr: 'Structure of the Basin Ranges.'

This paper describes the structure of many hitherto unstudied ranges in southern Nevada. The general structure is a series of open regular folds, with general north and south axes, accompanied by occasional parallel and transverse faults. Folding and faulting have gone on continuously since the region was upheaved at the close of the Jurassic. The present mountains owe their forms chiefly to erosion, which has been in progress, synchronously with the folding and faulting, since Jurassic time. The more common types are anticlinal ridges and synclinal valleys. The mountains are the compound result of erosion on rocks upheaved by these compound movements.

F. L. RANSOME,
DAVID WHITE,
Secretaries.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF GEOLOGY AND MINERALOGY.

AT the meeting on January 15, 1900, with Mr. G. F. Kunz in the chair, there were twenty persons present.

A report was presented by Professor J. J. Stevenson in behalf of the committee appointed November 20, 1899, in reference to the death of Sir William Dawson, of Montreal. On motion by Professor D. S. Martin, the report was adopted and recommended to the Council for printing.

The Chairman called attention to the coming meeting this year, in Paris, of the Eighth Session of the International Geological Congress, described the proposed excursions, and suggested the earnest coöperation of the Section by delegates, contribution of papers and financial aid. On motion by Professor J. F. Kemp, the matter of the representation of the Academy at the International Congress was referred to the Council for action.

A paper was read by Professor F. B. Peck 'On Serpentines and Talcs in the Vicinity of Easton, Pennsylvania,' with abundant illustrations by specimens of rocks, diagrams and lantern views.

In the subsequent discussion Professor Kemp stated that, in the talc deposits on the west side of the Adirondacks, described by Professor Smyth, the derivation of the talc had been attributed to the magnesium limestone or intrusion of a magnesium silicate rock.

Professor Peck replied that he considered the tremolite rock to be due to the alteration of a siliceous dolomite; the talc, possibly to the interchange of silica from the pre-Cambrian gneisses and magnesia from the adjacent dolomite limestone.

The serpentine and 'viridolite' had indeed been subjected to much shearing and fracture, but had been solidly re-cemented, so that they they could be quarried out in large blocks, free from cracks—sometimes of twenty tons weight, in the case of the 'viridolite.'

Professor J. J. Stevenson then discussed 'C. E. Bertrand's Theory respecting the Origin of Certain Coals.'

Mr. F. E. Lloyd remarked that the cells of algæ, to whose accumulation Bertrand and Rénaud mainly attributed the formation of these coals, are exceedingly delicate and often mucilaginous. Those of *sphagnum* are much thicker, solid and woody, and yet a large quantity of this is required to produce much deposit of carbonaceous matter in swamps.

The Chairman inquired whether freezing or the introduction of silty waters might cause the precipitation of ulmic acid referred to by these authors.

Professor Stevenson stated that ulmic acid so precipitated would tend to carry down suspended matters and to clear the waters.

A paper by Mr. H. Ries was then read, 'Note on the Occurrence of Allanite in the Yosemite Valley, California.'

While in the Yosemite Valley in September, 1899, my attention was attracted by a black, coaly-looking mineral in the pegmatite veins on the northwestern side of the Valley. On closer inspection the mineral proved to be allanite, and as it has not yet been recorded from this region, it seems of interest to note the fact.

The rock forming the walls of the Yosemite is a grano-diorite according to Turner (17th Ann. Rep. U. S. G. S., pt. I., p. 710). Traversing this in many directions are veins of pegmatite, which are sometimes straight and unbroken, at others curved, branched, or even broken into. These pegmatite veins are very prominent on the face of El Capitain, and also in the rock forming Eagle Peak. It was in the talus at the foot of the latter that the allanite was found, and while the mineral was at times abundant in the pegmatite blocks, still none of it was noticed in the grano-diorite. In only one instance was a distinctly bounded individual found, and on this a combination of orthopinacoid and base were recognizable. The other specimens were irregularly bounded grains that varied from a sixteenth to a quarter of an inch in diameter.

In addition to the quartz, muscovite and orthoclase present in the pegmatite, there were a number of radiating masses of epidote, which were evidently of primary origin; but in two instances the epidote occurred as a coating on hornblende and then seemed to be secondary. None was found in association with the allanite.

In conclusion, it may be said that it is interesting to find that allanite is evidently not the rare mineral that it was formerly considered to be, and that a careful watch is beginning to show its presence at many localities in the United States.

Alexis A. Julien,
Secretary of Section.

ONONDAGA ACADEMY OF SCIENCE.

At the January meeting the following officers were elected: *President*, John Van Duyn; *Vice-President*, J. D. Wilson; *Recording Secretary*, E. N. Pattee; *Corresponding Secretary*, H. W. Britcher; *Treasurer*, Miss L. W. Roberts; *Librarian*, Mrs. L. L. Goodrich; *Councilors*, G. A. Dakin, H. A. Peck and W. M. Beauchamp.

The annual report of the Geological Section showed that several investigations of local problems are being carried on and that some have been already completed during the year.

The report of the Zoological Section noted the occurrence within the county during the past year of the Bohemian wax wing, *Ampelis garrulus*, the jumping mouse, *Zapus hudsonius* and the hairy-tailed mole, *Parascalops breweri.* Additional localities were indicated for planaria, bryozoa and hydra. During the year fifty moths were taken, thus bringing the number of Lepidoptera of the county to over 600.

The report of the Botanical Section added the following plank to the county list: *Hyssopus officinalis*, *Chenopodium anthelminticum* and *Polygonum lapathifolium* with new stations for *Crepis virens*, *Glaucium glaucium* and *Scolopendrium.*

At the January meeting of the Geological Section, Professor E. N. Pattee reported on the progress of the investigations of the iron compounds of the county. The chief sources of these compounds are the red shales of the Salina formation, yielding small scales and flakes of hæmatite, the Corniferous, yielding crystals of pyrite and the Oriskany sandstone, yielding from one to five per cent. of iron, the color of the stone being, however, no index to the amount of iron, existing as a cement, which the rock contains.

H. W. Britcher,
Corresponding Secretary.

THE TEXAS ACADEMY OF SCIENCE.

During the last quarter of 1899 regular meetings of the Texas Academy of Science were held in the chemical lecture room of the State University on the second Friday evening of each month.

On October 13th, after a proper tribute to the worth and work of the late Dr. W. W. Norman, Professor of Animal Biology in the University and one of the most active members of the Academy, in which Messrs. Bray, Harper, Garrison, Sutton and others participated, Dr. Frederic W. Simonds, the incoming president, read his inaugural address, 'From the Standpoint of a Man of Science,' in which he made a vigorous protest against sham in all things, but especially in science, and an earnest effort to explain many of the popular misunderstandings of science and misconceptions concerning men of science and their work.

At the October meeting, Professor W. S.

Sutton, of the School of Pedagogy, read a timely and exceedingly interesting paper upon the 'Bachelor of Arts Degree,' in which he showed the origin of this ancient honor and its evolution until at the present time it stands for culture, and, in several prominent American institutions, has even become the sole mark of academic training.

The program for the December meeting was of two parts. The first, representing original investigation, consisted of two papers by Mr. E. T. Dumble, formerly State Geologist, entitled 'Cretaceous of Obispo Cañon, Sonora,' and 'Occurrence of Oyster Shells in Volcanic Deposits in Sonora, Mexico.'

Part second was of the nature of a symposium, in which the advancement of science during the past year occupied a conspicuous place. Dr. William L. Bray, discussed the 'Modern Trend of Botanical Studies,' showing clearly and forcibly the enormous strides made within the last few years; he pointed out the differentiation of the science of botany—how it had outgrown the grasp of any one man—and spoke briefly of its economic relations to many important industries.

Dr. Henry Winston Harper discussed the 'Recent Advances of Chemistry.' The solidification of hydrogen was, in his opinion, the most important chemical contribution to science during the past year. From a thermo-dynamic standpoint it is one of the greatest accomplishments of the nineteenth century, as it requires a temperature within 15° C. of the absolute zero. The study of the properties of matter at such extremely low temperatures is a virgin field for original investigation and phenomena of a most startling character may be looked for here. Some of the results of the latest research along this line were brought before the Academy. The advances of chemistry along many other lines were also discussed, especial stress being given to the recent utilization of the Indian corn plant, or maize, not only of the grain, but of the entire plant—pith, stalk and leaves. Professor Harper closed his discussion by reference to some recent developments of chemical theory, devoting particular attention to 'Werner's Theory of Coördinated Types.'

At a meeting of the Council, following this public session, Drs. Hilgartner, Bray and Bailey, were elected a Committee on Publication.

F. W. S.

University of Texas.

DISCUSSION AND CORRESPONDENCE.

FALSE BIBLIOGRAPHIC INDICATIONS.

To the Editor of Science: For some years past a few scientific Hamlets have been trying to set the time right in the matter of 'authors reprints,' 'Separat-abdrücke', or 'tirages à-part.' The most essential of their demands is that such separate copies should be furnished with correct bibliographic indications, and should retain the original page-numbers. They recognize with gratitude that the last ten years have witnessed a vast improvement in this respect. But a new terror has arisen, and appears so frequently and in so many quarters that it seems time to raise a vigorous protest.

It is not uncommon to be favored by an author with a copy of his latest work giving the desired bibliographic indications—name of periodical, volume, page, and plate numbers, and date of publication—and apparently with the type undisturbed. But should some chance lead one to the original, one finds that one or more, perhaps all, of these indications are incorrect; or else that the type has been shifted, so that matter appears on a page other than that which it originally occupied. Direct misstatements of this specious nature are worse than no statement at all.

It is not gracious to look a gift horse in the mouth, but some instances will make the point clearer and may serve as a warning. Be it understood that this is no question of mere incompleteness of information, simple repaging, or even incorrect dating, for examples of these offences are familiar to every serious worker and are remedied by him in due course. But take such a case as this: "Studier öfver den baltiske Yngre kritans bildningshistoria. Af Anders Hennig. Aftryck ur Geol. Fören i Stockholm Förhandl. Bd. 21, Häft 1., 1899." The pagination runs from 19–82, and appears to be, as indeed it is, the original pagination. Then comes 'Häft 2' and the paper is said to be continued from the preceding 'Häft.' The pagination also continues, 83–138. There is nothing to show that this is not the original pagination, and only the reader who chances to look up the original will find that the numbers should be 133–188 (with an addendum, not in the author's copy, on p. 218). Familiarity with the publications of the Stockholm Geological Society might arouse suspicion of the above. Let us turn to a case which seems a veritable Caesar's wife, extracted, as it is, 'from the Proceedings of the International Congress of Zoology, Cambridge, 1898,' edited by a very important person and printed by the University Press. It is 'On the Origin of Echinoderms, by Professor E. W. MacBride.' It bears all the characteristic signs of having been lifted without a tittle of alteration from the *Proceedings*, and the page numbers are 141–147. But in the *Proceedings* this paper appears on pp. 142–148.

Our next awful example hails from a Society which has done much to facilitate the work of zoologists: "Accidents will happen, etc." The paper is "Troisième note preliminaire du yacht *Princesse-Alice* * * * par E. Hérouard. Extrait du *Bulletin de la Société zoologique de France*, tome XXIV. * * * page 170." The pages of the extract continue regularly to page 176. Imagine the disgust of a Zoological Recorder, after entering all the new species-names on his slips, when he discovers by the merest chance that the original pages are 170–175 (not 176 at all) and that the type on every single page has been shifted. The converse of this Procrustean trick has been played upon "Notes biologiques sur quelques espèces d'Alphéidés observés a Djibouti, par H. Coutière. Extrait du *Bulletin du Muséum d'histoire naturelle*, 1897, no. 8, p. 367." The original pages, up to 370, are carefully given in [ ], and who would guess that there was ever a page 371, or that half of the text was on its wrong page? It is almost fortunate that the omission of the volume number and of the date of publication forces one to look at the *Bulletin* itself, and so discover the error.

After this one does not wonder at the following enigma recently received from a British Colony: "On some Cambro Silurian and Silurian Fossils from Lake Temiscaming, Lake Nipissing and Mattawa, by Henry M. Ami. * * * Extra. Ann. Rep. Geol. Surv. of Canada, Vol. X, Part I, Appendix II, pp. 282–301, Ottawa; Sept. 1899." Thus runs the wrapper. The title in the text adds "outliers" to the title; but a wrapper-title is not supposed to be correct. (*Why* not?). The pages of the text are 2891–3021. These figures are not merely irreconcilable with those on the wrapper, but suggest that "Part I" does not mean "Part One" at all, since the I is probably intended as a letter of the alphabet not as a Roman numeral. But this riddle is not yet solved, since the *Report*, here said to have been published four months ago, has not yet crossed the Atlantic.

These instances have not been selected for their intrinsic importance, but just as samples, all received within a few days of one another by a single individual. Each in itself seems trivial, but even a professional in touch with the best libraries in the world will be lucky if he can correct these five references in less than an hour. If he innocently accepts them he must not be surprised if he is abused some day as a careless worker, and his purely scientific observations mistrusted. If he incorporates them in a professed bibliography, the accuracy of his work will ever after be suspected and its value thereby seriously impaired.

Now the *fons et origo malorum* is not the author, who has very little to say in the matter, but the printer with his curious conventions of space and form, and his excusable ignorance of the needs of the working naturalist. The remedy lies, if anywhere, in the hands of the editor: he, who has the power, should also accept the responsibility. If the editors of our scientific publications would but realize the perpetual inconvenience that is caused by a little want of thought, and would but give clear and definite instructions to their printers to place the required bibliographic indications at the head of each reprint, to retain original pagination, and never to shift the type without duly stating the fact—then the amount of time saved by the numerous workers who have to rely upon authors' copies would be far greater than most people have any idea of.

F. A. Bather.

Natural History Museum,
London, 20 Jan., 1900.

FOSSIL-HUNTING IN WYOMING.

EDITOR OF SCIENCE: An article on 'Fossil-hunting in Wyoming,' published in the January issue of *The Cosmopolitan*, contains some inaccuracies which ought to be corrected. The present writer feels called upon to make these corrections. As many of the illustrations used in the *Cosmopolitan* article were from photographs of the Field Columbian Museum quarries, the erroneous impression has gone out in certain quarters that members of this institution were responsible for some of the misstatements, especially one which has been interpreted as a reflection upon a man to whom the science of paleontology owes much. I wish, therefore, to give a brief history of the discovery and collection of Dinosaurs in America, which I have sought to make as accurate as possible. The data regarding their discovery and early collection have been furnished me by Dr. Williston, whose association with Professor Marsh during his early work upon the Dinosaurs places him in position to speak authoritatively.

The first Jurassic fossil discovered in America was described in 1870 by Leidy under the name *Antrodemus* (*Labrasaurus*, Marsh, *fide* Lucas). Professor Arthur Lakes of Golden, Colorado, was, however, the first to recognize and appreciate the value of the deposits. In March, 1877, he located the horizon near Morrison, Colorado, and immediately sent specimens to Professor Marsh. Almost contemporaneously but a little later, fossils were discovered at Cañon City, Colorado, by O. Lucas, a teacher, and in Wyoming by W. H. Reed, a section foreman on the Union Pacific railroad. Reed, however, did not make known his discoveries until the following autumn and so forfeited any claim to priority.

In December of the same year Dr. Williston, who had been collecting for Marsh at Cañon City and later at Morrison, was sent to investigate the discovery reported by Reed at Como, Wyoming. Under his directions and assisted by Reed, quarry 1. of the Como series was at once opened and the work continued until late in the winter. During the succeeding years collecting was actively carried on in the Como region and as many as thirteen quarries in all were opened by the various men who had charge of the work. Collecting was carried on exclusively by Marsh for two or three years, at the end of which time Cope sent men into the immediate vicinity. After the Como quarries were abandoned, no collecting was done in the Jurassic beds for a number of years and the impression went out that the locality was exhausted. Interest in the beds was, however, revived by Professor W. C. Knight of the University of Wyoming, and W. H. Reed, who as early as the summer of '94 located and opened a new quarry at Mexican Mines, Wyoming. In the following summer Dr. Williston with a party from Kansas University was invited to share with them their new prospect. In '96 collecting was continued by the University of Wyoming in the Jurassic beds south of Laramie. In the spring of '97 the American Museum of New York sent men into the old Como locality to reopen Marsh's mammal quarry; but finding more promising material in the Dinosaur beds, their attention was turned to them. About the same time Knight's men opened quarries in the Freeze-out Hills. During the following year collecting was actively carried on by these two parties in their respective localities, and valuable quarries opened by both.

In '99 unusual attention was attracted to the Dinosaur beds of Wyoming by various press reports more sensational than accurate. In addition to the two institutions which had been carrying on active work, parties were sent out by the University of Kansas and by the Carnegie and Field Columbian museums. The Union Pacific railway also organized an excursion to the fossil fields, which brought not only paleontologists and geologists, but men interested in almost every branch of natural science to look at this new Eldorado. Among the new quarries opened during the year, those of the Carnegie Museum and Kansas University proved especially productive.

The valuable deposit worked out by the Field Columbian Museum party had not previously been passed over by 'a Kansas University professor,' as stated by the author of the *Cosmopolitan* article. On the contrary the quarry had been located and worked for some time by the Kansas University men. After they had taken out a large quantity of unusually good material and returned home, the Field Museum party made a new stripping beside the old and obtained from it large additions to its summer's collection. Photographs of the fossils exposed in the various stages of the work of this party formed the subjects of many of the illustrations used in the *Cosmopolitan* article.

ELMER S. RIGGS.

FIELD COLUMBIAN MUSEUM.
January, 23, 1900.

CURRENT NOTES ON PHYSIOGRAPHY.

PHYSIOGRAPHY OF JAMAICA.

IN connection with his studies of coral reefs, Mr. Alexander Agassiz has had surveys made of several West Indian islands by R. T. Hill, whose latest report is on the 'Geology and Physical Geography of Jamaica' (Bull. Museum Comp. Zool., Harvard College, xxxiv, 1899, 256 p., xli pl., including a topographical and a geological map). The island contains an interior mountainous area (the Blue mountains, 7360 feet), of greatly deformed rocks and of well subdued and elaborately carved form, occupying about one-sixth of the total area, chiefly in the east. A limestone plateau, whose gently arched strata were deposited unconformably upon the denuded older rocks during a period of submergence, rims around the eastern mountains and covers the central and western parts of the island to heights of 3000 feet; it is terminated toward the coast by strong bluffs, often terraced, 1200 feet high on the north. Below the bluffs, low plains descend gently to the sea. Solution has exerted great control over the drainage of the plateau, as may be seen in the interesting series of depressions, from incipient hollows of small size, to deep 'cock-pits' or sink-holes, and great basins, walled in by strong cliffs. Some of the basins still have underground drainage; others discharge their waters through canyons that have been formed by the retrogressive erosion of exterior rivers; while still others have lost their outer wall by the greater advance of erosion, subaërial or marine, and now form amphitheaters open to the coast. Inliers of older rocks sometimes rise in mountain form from the floor of the larger basin, as in Clarendon valley in the center of the island. The strata of the coastal plains lie on denuded benches of limestone or older rocks; their surface is diversified by coral reefs and transverse valleys, the first deposited, the second eroded during the time of elevation. The largest plain is that of Liguanea, upon which Kingston is situated.

The geological structure and history of the island, and its relation to the surrounding regions are fully discussed.

NICARAGUA CANAL ROUTE.

No article recently published gives better illustration of the practical value of the explanatory or genetic method in geographical description than that by Hayes on the 'Physiography of the Nicaragua Canal route' (*Nat. Geogr. Mag.*, x, 1899, 233–246; see also SCIENCE, x, 1899, 97–104). One feels on reading it that the author has critically observed the salient facts and that his account of them fully expresses the results of his observations. The region described may be divided into three parts: The upland traversed by the San Juan river from Lake Nicaragua eastward to the Carribbean, the basin of the lake, and the upland or continental divide that separates the lake from the Pacific. The eastern upland is part of an uplifted and dissected peneplain, 100–200 feet above sea level, and bordered by hills and mountains on the north and south. Its revived streams still run nearly at the upland level in their upper courses; then they descend rapidly in young valleys that they are still deepening to aggraded alluvial floors, which suggest a recent depression after the time of first valley cutting. The lake now stands where a bay once opened northwest to the Pacific; the eastern upland was then the continental divide. The bay seems to have been formed by warping or faulting a western portion of the peneplain above referred to. Numerous volcanic cones grew on the bay floor and converted its head into the lake, whose level rose until an eastern overflow formed the San Juan river, now cutting a trench across the eastern upland. The southwestern barrier of the lake seems to be another part of the peneplain, warped so as to give a steep descent to the Pacific and a gentler descent to the lake. On account of the unequal slopes thus determined, several Nicaraguan streams have lost their headwaters to the Rio Grande, which enters the Pacific at Brito; and the point where one of the now beheaded Nicaraguan rivers rises on its old valley floor is the lowest pass on the present continental divide, and hence is selected for the path of the canal from the lake to the ocean. A fuller discussion of the region is given by the same author in *Bulletin of the Geological Society of America* (x, 1899, 285–348).

THE PLAINS OF RUSSIA.

A NOTE in SCIENCE, May 2, 1898, was in error in describing the plains of central Russia as dipping under the drift sheet on the northwest. The plain is continuous across the older rocks and the drift sheet of the first glacial invasion, and both areas are to-day dissected similarly by valleys. Philippson returns to this subject (*Pet. Mitt.*, xlv, 1899, 269–271) to emphasize his conclusion that the paleozoic and mesozoic area of the plain is a surface of denudation, now broadly uplifted and somewhat dissected; the denudation being completed contemporaneously with the formation of the drift plain. The rivers may have followed shallow depressions in the surface of the great plain, but the valleys of to-day are undoubtedly the work of erosion after uplift, and hence all of quaternary date. Even the broad and unsymmetrical valley of the Volga is held to be of later origin than the first glacial epoch. Small rivers have cut valleys 100 meters deep, either entirely in the older rocks, or in the drift area, or passing back and forth from one to the other. Most of the valleys are of a considerable width already, with well graded floors; but where the Dneiper crosses the granite swell of southwestern Russia there are rapids in its course. Philippson urges that the solution of morphological problems of this kind should not be postponed until the completion of detailed geological surveys, but that they should be studied during the prosecution of the surveys; he also wishes fuller information from the Russian geologists concerning the date of folding in the Urals and of their later upheavals after extensive denudation.

THE AMALFI LANDSLIP.

THE Boston *Transcript* of January 13th gives a translation from an Italian newspaper, *La Tribuna*, describing the landslip at Amalfi on December 23d, last. For several days preceding the disaster a trembling motion had been noticed in the mountain over the town and many peasants had left their houses. Early on the morning of the 23d, a noise like that of splitting wood was heard in Hotel Santa Caterina on the mountain slope, and a crack was found in one of the walls. A man from a quarry brought news that a small fissure had opened in the mountain side. Soon afterwards stones began to roll down the steep slope at more and more frequent intervals, and then a mass of rock estimated at 30,000 cubic meters broke away from the mountain and fell with terrible noise, crushing everything in its way and raising a dense cloud of dust. Some peasants working on the upper slope saw a long fissure open 'beneath their feet' and had only time to leap aside before the ground on which they had been standing broke away and fell. Others working at a lower level were killed. The sliding mass swept away a peasant settlement on the upper slope, buried the Hotel Caterina, crushed one end of the old monastery known now as the Hotel Cappuccini, a favorite resort of travellers, and then ran into the sea, destroying two boats, capsizing two others, and obstructing the shore waters. The highway near the shore was covered and all travel on it was suspended for fear of later disasters. Along the track of ruin for some distance up the mountain side, houses are demolished, trees uprooted, and gardens overwhelmed. A number of lives were lost, and the damage is estimated at over 1,000,000 lire.

W. M. DAVIS.

CURRENT NOTES ON METEOROLOGY.

A NOTEWORTHY BALLOON VOYAGE.

AN interesting point in connection with a recent balloon trip is noted in the *Zeitschrift für Luftschiffahrt* for December. The trip in question was made by MM. de Saint-Victor and Mallet, starting from Paris on September 30th last, at 6:15 p. m., and landing near Vestewick, in Sweden, on the evening of the following day. The duration of the trip was 23¼ hours, and the distance passed over was 1330 kilometers, or about 825 miles. The point referred to concerns the effect of a water surface upon the temperature of the air at the altitude of the balloon (about 500 meters). At about 9 a. m. on October 1st the balloon began to drift over a part of the Baltic Sea, and the aëronauts at once noticed a fall in temperature and an increased humidity in the air through which they were moving. In consequence of these changed conditions, the balloon began to descend, and it was necessary to throw out ballast in order to maintain it at a proper altitude.

THE BAGUIOS OF THE PHILIPPINE ISLANDS.

In the *Monthly Weather Review* for October, Abbe notes that in speaking of tropical cyclones, the word *cyclone* should uniformly be employed for all revolving storms, or else that names should be used which have a widespread local usage. Thus the term *hurricane*, which has its root in the Carib word *ourgan*, should, at least in English works, be restricted to the violent tropical cyclones of the North Atlantic Ocean. *Typhoon* has been the recognized designation of the revolving storms of the China Sea for many years. And now the term *baguio*, which is commonly used by the Tagalogs and Viscayans seems likely to come into use. *Baguio* is the name universally applied in the Philippine Archipelago to the storms that, after they pass westward over the Archipelago, become *typhoons* on the coast of China.

THE DROUGHT IN INDIA.

It has for some time been the custom of the Indian Meteorological Department to issue long-range forecasts of the monsoon and cold weather rains in India. From *Nature* for January 11th we learn that this year the forecast of the cold weather (December–February) rains in northern and central India anticipated a rainfall slightly above the normal. The prediction has unfortunately not been verified, as an area comprising nearly two-thirds of India is now suffering from the most severe drought of the century, and there does not seem, at present, to be any immediate chance of a change for the better.

METEOROLOGICAL CHART OF THE GREAT LAKES.

There has been issued by the Weather Bureau a publication entitled *Meteorological Chart of the Great Lakes: Summary for the Season of 1899*, by A. J. Henry and N. B. Conger. This quarto pamphlet summarizes the information contained in the monthly meteorological charts of the Great Lakes, issued throughout the navigation season. The discussion concerns the storms of the year; precipitation and the possibility of evaporation in the Lake region; fog; ice during the winter of 1898–99, and the wrecks and casualities which occurred during the year. A dozen charts illustrate the text.

R. DeC. Ward.

WAGNER FREE INSTITUTE OF SCIENCE.

The lectures for the spring term at the Wagner Free Institute of Science will commence on Monday, February 12, 1900. The following is the schedule:

Mondays, Dr. Henry Leffman, 'Chemistry.'

Tuesdays, Professor W. B. Scott, 'Dynamical Geology.'

Wednesdays, Professor R. E. Thompson, 'American History, 1783–1865.'

Thursdays, Professor G. F. Stradling, 'Heat.'

Fridays, Professor S. T. Wagner, 'Metallic Materials of Engineering Construction.'

Fridays, Professor T. H. Montgomery, 'Invertebrate Animals.'

Saturdays, Dr. Emily G. Hunt, 'Some Aspects of Botany.'

At the annual meeting at the Institute Mr. G. H. Cliff, formerly president of the Girls' Normal School, was elected a trustee to succeed the late Richard B. Westbrook, Esq.

From the report of the Actuary it was learned that 13,828 persons had attended the Fall course of lectures, that 28,378 persons had used the Reference Library and that the Branch of the Free Library had circulated 269,618 volumes for home use; 1327 books and 2226 pamphlets and magazines were added to the Wagner Institute Reference Library during the year. The report dwelt at some length upon the splendid collection of government documents owned by the Institute, probably the best in the City of Philadelphia, which was now classified and was being thoroughly catalogued. The thanks of the Board were extended to the officers of the Spring Garden Institute for an important addition to this collection.

The Board has given permission to the Philadelphia Natural History Society to hold its meeting in the Institute. This Society is in a most flourishing condition and there is an average attendance at the meetings of from 35 to 40 persons.

The number of accessions to the Museum during the year was 386, making a total of 14,880 exhibits, not including the insects of which there are about 5000 species. The collection of Florida Pliocene Fossils is one of the best and most complete in the country. Among the most important contributions are 100 species of fossils collected by Dr. H. G. Griffith on the Caloosahatchie River, Florida; 50 species of minerals presented by Mr. Joseph Wilcox, a number of zoological crustacea and mollusks collected by the Zoological Expedition to Florida in June, 27 local species from the Academy of Natural Science Exchange, 22 species of birds and nests from J. Harris Reed, and a collection of coal plants from the Rock Hill Coal and Iron Company. The local collection of insects is now the most complete in the City.

SCIENTIFIC NOTES AND NEWS.

MAJOR J. W. POWELL, director of the bureau of American ethnology, and Professor W. H. Holmes, head curator of anthropology in the United States National Museum, are in Cuba engaged in carrying out a plan for archæologic researches which are expected to throw light on pre-historic migrations of several native tribes, as well as on aboriginal commerce and interchange of arts. Their operations will extend to Puerto Rico and several other Antillean Islands.

THE REV. FATHER JOSÉ ALGUE, director of the Manila Observatory, and his associate, Father José Clos, have arrived at San Francisco on their way to Washington. They wish to arrange for the continuation of the work of the Observatory and the publication of the results by the government.

PROFESSOR A. J. HENRY, who has been for twenty years connected with the Weather Bureau and who is at present chief of the Division of Meteorology, has been appointed to fill the vacancy caused by the death of the late H. A. Hazen.

MR. A. A. HELLER has returned to Puerto Rico to extend his collections made in 1899 for the New York Botanical Garden. He will keep the field during January and February, with headquarters at Mayaguez in the western part of the island.

WE are glad to learn that Professor R. H. Chittenden of Yale University who has been seriously ill with typhoid fever is now better.

WE learn from *Nature* that the Council of the Manchester Literary and Philosophical Society have awarded the Wilde Medal for 1900 to Lord Rayleigh, for his contributions to mathematical and experimental physics and to chemistry; a Dalton Medal (struck in 1864) to Sir H. E. Roscoe, for his remarkable original researches in chemistry, and for his distinguished services to scientific education; and the Wilde Premium for 1900 to Professor A. W. Flux, for his papers on economic questions read before the Society. The presentation of the medals and the premium took place at a special meeting, when Lord Rayleigh delivered the Wilde Lecture for 1900.

M. POINCARÉ has been awarded the gold medal of the Royal Astronomical Society.

IT is understood that Sir John Lubbock, on his elevation to the peerage, has decided to take the name of Lord Avebury, after a property of his in Wiltshire. According to Sir John Lubbock's description in 'Prehistoric Times,' the temple of Avebury, Wiltshire, was the greatest of all so-called Druidical monuments.

M. M. DARBOUX and Moissan have been appointed delegates of Paris Academy of Sciences to the celebration of the second centenary of the Berlin Academy of Sciences.

AT the annual meeting of the Royal Meteorological Society, London, on January 17th, Mr. G. J. Symons, F.R.S., was elected president for the ensuing year.

AT the first meeting of the Académie de Médecine for 1900 the retiring president, Professor Panas, gave his valedictory address, reviewing the important work and communications of the past year. Professor Marey succeeds him in the presidency and Professor Guyon has been elected vice-president.

The annual general meeting of the Neurological Society of London was arranged for February 8th, when it was expected that the president-elect, Dr. A. D. Waller, F.R.S., would deliver an address on the 'Excitability of Nervous Matter, with special reference to the Retina.'

We regret to learn of the death of Mr. John Bernard Stallo, who died at Florence, on January 6th. He was born in Oldenburg in 1823, and came to the United States when he was sixteen years old. Mr. Stallo was a lawyer by profession, had been a judge at Cincinnati, Ohio, and had been minister of the United States at Rome, and had lived in Italy since 1885. He was the author of a volume in the International Scientific Series entitled, 'The Concepts and Theories of Modern Physics,' which is in many ways a remarkable and important work. He was also the author of 'General Principles of the Philosophy of Nature,' and 'Redung. Abhandlungen und Briefe.'

A telegram has been received at Harvard College Observatory from Professor Kreutz, at Kiel Observatory, stating that a comet was discovered by Giacobini at Nice, January 31^d.292 Greenwich Mean Time in R. A. 2^h 57^m 44 and Dec. — 7° 55′.

A committee of the Pan-American Medical Congress has asked the U. S. Department of Agriculture to coöperate with other nations in an investigation of the medicinal flora of the United States, and Secretary Wilson has asked for an appropriation of $10,000 for this purpose.

On the 21st of February the Senate committee on the District of Columbia will hold a hearing on the subject of the anti-vivisection bill now pending before the Senate. This hearing will be attended by leading advocates of vivisection from all parts of the country, as well as by those who favor the pending bill. Dr. W. W. Keen, president of the American Medical Association, has published in the *Philadelphia Medical Journal* an appeal to the medical profession of the United States in regard to the bill. Dr. Keen in his appeal states that the "Bill is speciously drawn to seem as if it were intended only in the interest of prevention of cruelty to animals," that the "real object of the Bill is twofold: first, to prohibit vivisection, and secondly, to aid the passage of similar Bills in all the State Legislatures." He says "that this would seriously interfere with, or even absolutely stop, the experimental work of the Bureau of Animal Industry, and the three medical departments of the Government—the Army, the Navy and the Marine Hospital Service." He therefore appeals "to the entire profession of the country to exert themselves to the utmost to defeat this most cruel and inhuman effort to promote human and animal misery and death, and to restrict scientific research."

The Senate Committee on Commerce, on February 1st, practically decided on a favorable report upon the bill creating a department of commerce, but owing to the desire to change some of the details of the measure, it will not be reported for some time.

At a recent meeting of the Board of Trustees of the University of Wyoming, the herbarium connected with this institution was officially recognized as The Rocky Mountain Herbarium, and Dr. Aven Nelson, professor of botany in the University, was named curator. The object of the herbarium is to make an accessible and serviceable collection of the plants of the Rocky Mountains. The collection will be a general one but plants of economic importance will have special attention. It is especially desired to represent fully forage of all kinds, useful and ornamental trees and shrubs, and herbaceous plants which are of interest to the gardener or are desirable for the decoration of the home grounds. Besides these the parasitic fungi and the fleshy fungi are to be fully represented. The present collection numbers nearly 18,000 sheets. The coöperation of botanists and collectors is requested. Sets of plants collected in the Trans-Mississippi portion of the United States are especially desired as well as co-types or representative specimens of new species from this region. Correspondence concerning specimens and exchanges should be directed to the curator.

Plans are being made for the enlargement of the John Crerar Library, Chicago, which it will be remembered is devoted to scientific works. The Library at present occupies the sixth floor of the Marshall Field building, and a part of the fifth floor is now to be added. A room will be provided for society meetings. The number of accessions to the library during the past year is 12,360, and the total number of books and pamphlets in the library is now 80,000.

MME. MEDVEDNIKOVA, who died recently near Moscow, has left $3,000,000 to charities, chiefly to hospitals and asylums.

THE department of superintendence of the National Educational Association will meet in Chicago on February 27th and 28th, and March 1st. Professor Nicholas Murray Butler will make an address at the first sesson on the 'Status of Education at the Close of the Century.' Other addresses will be made by President Benjamin Ide Wheeler of the University of California, Mr. Walter H. Page, and others. Professor W. O. Atwater, of Wesleyan University, will present a paper on alcoholic physiology and superintendence.

AT a meeting of the Royal Geographical Society held on January 23d, in the theatre of the University of London, Mr. H. J. Mackinder, reader in geography at the University of Oxford, read a paper describing his recent journey to the summit of Mount Kenya, British East Africa. The results of the expedition were a plane-table sketch of the upper part of Kenya, together with rock specimens, two route surveys along lines not previously traversed, a series of meteorological and hypsometrical observations, photographs by the ordinary and by the Ives color processes, collections of mammals, birds and plants, and a small collection of insects.

THE new German Society for Volkshygiene held its first public meeting during January in Berlin. Dr. Boediker took the chair, and there were delegates present from the German Ministry of the Interior, from the municipalities of Berlin and Charlottenburg, and from the government of the Province. Professor Fuchs, rector of the University, and Professor Riedler, rector of the technical high school, were also present, and many medical men of distinction, among them Professors v. Leyden, Jolly, Ewald, Rubner, and Lassar. In his introductory address, the president described the objects of the new Society.

THE New York *Medical Record* gives the following summary of the invasion of the Islands of the Pacific by the plague : In Honolulu, up to January 17th, there had been thirty-nine deaths, one of a white woman and the others among natives and Asiatics. The board of health has burned ten blocks of houses in the plague-infected section. A Red Cross society, formed by some of the ladies of Honolulu, has done most effective work, and the local physicians and clergymen have continually gone among the sick and dying, submitting to voluntary isolation in order to minister to the needs of the sick. In Noumea, New Caledonia, the disease has prevailed since early in December. There were sixteen deaths during the first ten days following the development of the malady. Up to December 23d there had been no deaths among the whites, eight of whom had been infected, but nine Kanakas, two Japanese, and five Tonkinese had died of the disease. The part of the town where the infection first developed has been surrounded with a high galvanized iron fence seven hundred yards long. The principal business houses, official buildings, and the banking and shipping offices are guarded by posses of soldiers. Twenty buildings in the infected quarter of the town were demolished by the health authorities, but, despite all the precautions, the plague has continued to spread, the number of new cases averaging three daily. At Sydney, New South Wales, general alarm is felt in consequence of the arrival of eleven passengers from Noumea, who landed before news of the plague's presence was received. Extraordinary precautions have been taken throughout Australia and strict quarantine is established. In the case of a wharf laborer in Sydney, who was attacked on January 24th, the inoculation was apparently traced to a flea bite. In Argentine Republic the plague is officially announced to exist at Buenos Ayres and Rosario, both of which ports have in consequence been closed.

THE *British Medical Journal* states that the King of Italy has promised to open a hygienic exhibition at Naples in April, and it will remain open until September. The construction of the buildings is being pushed on with great zeal, and funds are assured partly by direct donations and partly by redeemable shares. Several conferences will be held. The most important will be those on the prevention of tuberculosis, and on the promotion of physical education. Amongst the most interesting 'side shows,' will be an exhibition of works of 'Sacred Art.' The Minister of Public Instruction has directed that objects of this description at present located in public museums and buildings shall be lent. There will also be a 'Pompeian Pavilion,' in which will be reproduced the public and private baths of Pompeii and other objects of interest.

THE Medical Society of the State of New York held its 94th annual meeting, at Albany, on January 30th and 31st, and February 1st. We learn from the report in the New York *Medical Record*, that the inaugural address of the president, Dr. W. G. Macdonald, reviewed especially the work of the Society. He said that the efforts of the Society's committee and of the New York Bar Association to improve the status of medical expert testimony had unfortunately resulted in nothing more than a better general understanding of the intricate problems involved. In the opinion of the speaker the legal profession is responsible for the present order of things. Presiding judges could readily remedy existing abuses by excluding medical advocates from the witness box. A voluntary society of men doing expert work could do much to regulate the condition. On the topic of State control of such chronic diseases as tuberculosis and syphilis, the speaker stated that the tendency at present was toward such State control and isolation in sanatoria. The Committee on Legislation reported that two hundred and sixty-five bills of a medical nature had claimed the attention of the committee during the four months' session of the last legislature. The committee on the United States Pharmacopœia, favored the establishment of a bureau of materia medica for the disinterested investigation into the character and value of new drugs, the bureau to be under the authority of the dicennial convention of 1900, subject to the provision that this bureau should report annually. The Society recommended the continuation of the State appropriation for the support of the Pathological Institute, but there was some criticism of its methods.

UNIVERSITY AND EDUCATIONAL NEWS.

THE Regents of the University of California have adopted the policy of giving the professors of the University one year's leave of absence in seven. They are usually to receive two-thirds of the regular salary, but those who have not yet received a leave of absence may receive full salary.

IT is now said that the decision of the Court of Appeals of New York sustaining the will of William Lampson, ends the litigation over his will, so far as any question of law is concerned. The heirs, however, will contest the will on the ground of the incompetency of the testator. The value of the propeerty which is largely real estate is estimated at $350,000 or more.

PRESIDENT LOW of Columbia has been asked to deliver the address at the celebration at Dartmouth College next year of the centennial anniversary of the graduation of Daniel Webster from that institution.

DR. G. A. MILLER of Cornell University was recently elected to membership in the Mathematical Society of France.

M. GABRIEL TARDE, well known for his contributions to psychology and sociology, has been elected to the chair of modern philosophy in the Collège de France.

PROFESSORS Ebner and Schaffner, who have hitherto acted as assistants in the Embryological Institute of the University of Vienna, have been appointed acting directors on the retirement of Professor Schenk.

DR. A. KLAUS, professor of chemistry in the University of Frieburg in Br., has retired on account of ill health.

SCIENCE

FRIDAY, FEBRUARY 16, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE VAN'T HOFF CELEBRATION.

A QUARTER of a century has passed since Van't Hoff obtained the degree of Doctor of Philosophy. This event was celebrated on December 22, 1899, in Rotterdam, by his students and a number of guests, including some of the leading men of science. An extra volume of the *Zeitschrift für physikalische Chemie*, containing investigations by those who, at some time, had worked with Van't Hoff, was published and presented to him on this occasion.

What does this mean; why has such an unusual tribute been paid to this comparatively young man?

There is nothing more inspiring to workers in the field of science, than the lives and works of those who are the leaders of modern science. Let us turn to the biographical sketch of Van't Hoff, by Ostwald, which serves as a preface to the 'Jubelband.'

Van't Hoff is the son of a Dutch physician, and was born in Rotterdam, August 30, 1852. He received his early training at a high school in his native city, and at seventeen entered the Polytechnic Institute in Delft. He then studied at Leiden, with Kekulé at Bonn, and with Würtz in Paris. He made the doctor's degree at the University of Utrecht, on the 22d of December, 1874. In 1876 he became docent at the veterinary school in Utrecht, and in 1877 was called to the University in Amsterdam. In 1894 he left Amsterdam to accept a chair of Physical Chemistry at the University of Berlin, which had been founded especially for him.

Van't Hoff's contributions to science fall into three classes ; or we may say, in brief, he has done three things. His earliest work of importance had to do with the spatial arrangement of the atoms in the molecule. In the same year in which he obtained the degree of Doctor of Philosophy, he published a small pamphlet of eleven pages, which is the beginning of all stereochemistry. In the following year it was enlarged to forty-four pages, and published in French under the title, "La chimie dans l'espace." It was translated into German two years later, with an enthusiastic preface by Wislicenus.

The attitude of Kolbe, who utilized his position to belittle not only the work but also its author, is familiar to every one. Indeed, so familiar, that Kolbe's reputation for liberality is not materially increased by the criticism which he offered of this work.

Van't Hoff attempted, in this work, to formulate a rational theory of the arrangement of the atoms in the molecules of certain substances. Let us consider the very simple compound of carbon and hydrogen, CH_4. All the properties of this substance show that it is a symmetrical compound, every hydrogen atom bearing exactly the same relation to the molecule. By what possible geometrical configuration in three dimensions can this be expressed? Evidently by the regular tetrahedron, and by this alone. If we represent the carbon atom as being placed at the center of a regular tetrahedron, and the four hydrogen atoms at the four corners, or in the four solid angles of the tetrahedron, we have a perfectly symmetrical configuration. This was pointed out by Van't Hoff, and has come to be known as the 'theory of the tetrahedral carbon atom.'

One application of this theory will serve to show how it has been of service in advancing our knowledge of organic substance. A comparatively large number of compounds were known, which, in the liquid state or in solution, would rotate the plane of polarization when a beam of polarized light was passed through them. In some cases the rotation was to the right, in other cases to the left. Further, it was very probable that for every substance which rotates the plane of polarization in one direction, there is a substance of the same composition rotating the plane in the opposite direction. How could these facts be interpreted in terms of the theory of the tetrahedral carbon atom?

Van't Hoff pointed out that every one of these so-called optically active substances contains a carbon atom in combination with *four different atoms or groups.* It is only when the four atoms or groups at the solid angles of the tetrahedron are all different, that two configurations are possible. If any two of the atoms or groups are the same, it is impossible to construct two tetrahedra which shall differ from one another. But if the four atoms or groups are all different, two tetrahedra can be constructed which bear the relation to each other of an object and its image in a mirror. These two configurations represent the two substances which have the same composition, but are optically active in opposite senses. When this theory of 'the asymmetric carbon atom' is applied to all of the facts known concerning optically active substances, we find that out of the seven hundred optically active compounds, there is only *one* which may be an exception to it. But this substance is so complex that its constitution is far from settled.

This is but one application of the theory of the tetrahedral carbon atom. This theory has thrown entirely new light on the meaning of isomerism in organic chemistry. By means of it many cases of isomerism have been satisfactorily explained, whose meaning was entirely shrouded in darkness before the theory was proposed. By means of this theory large numbers of isomeric substances have been predicted, and many of these have already been discovered.

The theory of the space relations in carbon compounds has led directly to a theory of the stereochemistry of compounds containing nitrogen, and some extremely interesting and important work has been done in the last ten years upon this problem. Under the guidance of these new conceptions entirely new classes of compounds have been brought to light, and cases of isomerism discovered whose existence could never have been suspected, had not the theory of the tetrahedral carbon atom been proposed.

If we look over the field of organic chemistry in a broad way, it is not too much to say that the most important advances which have been made in organic chemistry in the last quarter of a century, have centered closely around this theory of the tetrahedral carbon atom. If we think only of the applications of the theory which have been made by Wislicenus, Hantzsch, and Emil Fischer, we shall see that it has contributed more to the advancement of our knowledge in this field, than any suggestion since Kekulé proposed the benzene hypothesis which bears his name.

In 1878 Van't Hoff published a book which is but little known, and which has had but little direct influence—'Ansichten über die organische Chemie.' But this book is closely connected with his second great contribution to chemistry.

He attempted to develop a side of organic chemistry which had hitherto received but very little attention. What would be the effect of different masses of one substance when allowed to act on a given mass of another substance? This quantitative side of organic chemistry had been either entirely neglected, or dealt with only as affecting the yield which would result from the reaction. Van't Hoff applied the law of Guldberg and Waage to organic reactions, and pointed out the importance of the study of the dynamics of reactions. He studied the velocity with which given reactions would take place, and the conditions under which equilibria in chemical processes were established. His first results were published in his 'Études de Dynamique Chimique' in 1884.

The work is not simply experimental. Indeed its theoretical side is of the very highest importance, since it was shown here that we can apply thermodynamics to chemical processes. The whole science of chemical dynamics and statics has acquired an entirely new meaning in the light of this work, which has contributed more to place organic chemistry on a quantitative basis, than any investigation which has ever been published. This work was greatly enlarged and published in 1896, under the title 'Studien zur chemischen Dynamik,' by Van't Hoff and Cohen.

The second epoch-making work of Van't Hoff is much less widely known than the first. This is due in part to the comparative complexity of the processes dealt with, and in part to the rigorous mathematical treatment which he applied to them. But I believe that time will show that the *Chemical Dynamics* of Van't Hoff is vastly more important than his *Stereo-chemistry* in placing chemistry upon that exact mathematical basis, toward which all branches of natural science tend, as our knowledge of the phenomena becomes deeper and deeper.

The third great work of Van't Hoff still remains to be considered. I refer to the relation which he showed to exist between the pressure of gases and the osmotic pressure of solutions. The genesis of this idea has been furnished us by Van't Hoff himself, in the lecture which he was invited to deliver before the German Chemical Society in 1894. As we have seen, he was early occupied with the study of the position of atoms in space. From this he was led to study the velocity of reactions and the conditions of equilibrium in chemical processes. But the problem of affinity was closely connected with that of equilibrium. As an example of affinity he studied the attraction of salts for their water of crystallization. He found this to be very small and adds: "I had the impression that even the weakest chemical forces are very large. * * * The question arose whether it is not possible, in simpler cases, to measure the attraction for water more directly; and for this purpose the aqueous solution is the simplest conceivable—much simpler than the compound containing water of crystallization. Coming from the laboratory with this question in mind, I meet my colleague De Vries, and his wife. He was just at that time carrying out osmotic investigations, and he told me about Pfeffer's determinations."

Van't Hoff was thus introduced to the work of Pfeffer, in which the latter had measured the osmotic pressure exerted by aqueous solutions of a number of substances, when separated from the pure solvent by a semipermeable membrane, through which the solvent, but not the dissolved substance, could pass. Van't Hoff observed from Pfeffer's results, that the osmotic pressure exerted by any substance at a constant temperature is proportional to the concentration of the solution, and saw in this an analogy to Boyle's law for gas-pressure. The gas-pressure of a gas is proportional to the concentration of the gas. Having found this one relation between osmotic pressure and gas-pressure, he tested other laws of gas-pressure by the osmotic pressure of solutions, and found that the law of Gay Lussac for the temperature coefficient of gas-pressure, applies also to the temperature coefficient of osmotic pressure. These two laws of gas-pressure might apply to the osmotic pressure of solutions, and still the absolute value of the two pressures be very different.

The fundamental question still remains: Is there any close relation between the actual pressure exerted by a gas, and the osmotic pressure exerted by a solution containing the same number of dissolved particles in a given space as there are gas particles; temperature, of course, being the same in the two cases? Van't Hoff discovered this remarkable fact; that the gas-pressure exerted by a gas particle is *exactly equal* to the osmotic pressure exerted by a dissolved particle, concentration and temperature being the same in the two cases; space playing a rôle with gases, which is analogous to that of the solvent with solutions. In a word, Avogadro's law for gases applies directly to the osmotic pressure of solutions. The three fundamental laws of gas-pressure thus apply directly to the osmotic pressure of solutions.

This relation is, in itself, of course very interesting. But why is it referred to as of epoch-making importance? Partly because of the new light which it throws on the whole problem of solution. We can apply thermodynamics freely to gases, and since the laws of gases apply to solutions, we can use thermodynamics in dealing with solutions in the same sense as in dealing with gases. And partly because it is the forerunner of the most important theory which has been proposed in chemistry or in physical chemistry for the last half-century.

We have stated that the laws of gas-pressure apply to the osmotic pressure of solutions, and this is true for solutions of certain classes of substances. It holds for all of those substances which, when in solution, do not conduct the current and therefore do not undergo decomposition. These substances are called non-electrolytes. But this relation does not hold for any substance which, when dissolved in water, conducts the current; and this class, called the electrolytes, includes all the acids, all the bases and all the salts. The exceptions to Van't Hoff's generalization are quite as numerous as the cases which conform to it; and the former are even more interesting than the latter.

To account for these exceptions it was assumed that in aqueous solutions of acids, bases and salts, the molecules are more or less broken down or dissociated into ions; the amount of the dissociation increasing with the dilution of the solution. An ion is an atom, or group of atoms, charged either positively or negatively. This suggestion, which has been placed upon its present quantitative bases by Arrhenius, is the direct outcome of the analogy between the laws of gas-pressure and of osmotic pressure, pointed out by Van't Hoff. The theory of electrolytic dissociation thus originated.

The importance of the discovery of the applicability of the gas laws to osmotic pressure can now be seen, when we consider that this relation, together with its direct consequence, the theory of electrolytic dissociation, are the two corner-stones of modern physical chemistry. Indeed, the physical chemistry of to-day has grown up almost entirely around these two conceptions. It is from these two generalizations, directly, that Nernst has calculated the electromotive force of primary cells, and has furnished us with the first satisfactory theory of the action of such cells. Still further, he has gone into the cell itself and analyzed its action, calculating the amount of potential which exists at the several sources of potential, and has shown that molecules as such have nothing to do with the action of the primary element; only the ions into which the molecules dissociate coming into play.

These generalizations have, on the other hand, entirely revolutionized our conception of chemical activity. We now know that a large majority of the chemical reactions with which we have to deal, take place entirely between ions; atoms and molecules as such, playing no rôle whatsoever in the reaction. Indeed, we have already reached a stage where it is safe to say that very few chemical reactions are other than ionic; and very recent work makes it more than probable that atoms and molecules are entirely incapable of entering into any chemical reaction. The chemistry of atoms and molecules is thus rapidly giving place to the chemistry of ions. But space will not allow further applications of these all-important generalizations.

In addition to these three monumental pieces of work, any one of which would secure permanent fame for its author, Van't Hoff has made a number of important contributions to science. His paper on *Solid Solutions* has called attention to an interesting and important class of phenomena, which had never been in any sense connected with solutions. And the activity which characterized the earlier years of his life still manifests itself to an unusual degree. This is seen in the number and nature of the investigations which are coming from his laboratory in Berlin, and in the volumes which are appearing from his pen.

If we take into account the nature and significance of the entire work of this remarkable man, it seems quite safe to predict that he will be regarded in the future as occupying a place in the same rank with men like Pasteur and Virchow, Helmholtz and Kelvin.

The celebration in Rotterdam in honor of the first twenty-five years during which Van't Hoff has worked for pure science, is a memorable event especially in the history of modern physical chemistry. There were present such men as Ostwald, Roozeboom, Lobry de Bruyn, Spring, Lorenz, Goldschmidt, Du Bois, Bredig, Ikeda, Dawson, De Hemptinne, Holleman, Jorissen, Reicher, Var Laar, Wind, Cohen, Meyerhoffer, and many others; including a large number of his students and friends.

The Burgermeister of Rotterdam made an address of welcome, which was followed by a second address by Ostwald. Telegrams were received from all parts of Europe, and cablegrams from America, Japan and Java; extending congratulations to Van't Hoff. Cohen, who was for a long time Van't Hoff's assistant in Amsterdam, prepared and presented to Van't Hoff a biographical sketch of the life of the latter, while Meyerhoffer presented the 'Jubelband.'

A word in conclusion in reference to this volume. Some two years ago a printed slip was sent to all who had worked with Van't Hoff, inviting them to contribute an original investigation to a volume which would be published and presented to Van't Hoff on the twenty-fifth anniversary of the day on which he received his degree of Doctor of Philosophy. A short time before the volume was published we were notified that it would appear as an extra volume of the *Zeitschrift für physikalische Chemie.*

It has thus appeared as volume 31 of this Journal and is known as the 'Jubelband für J. H. Van't Hoff.' Outside of its personal interest to those who have sent contributions, and of its scientific value, it has a linguistic interest. It contains papers in four languages: German, English, French, and Dutch. The papers are evidently published in the languages in which they were written by the contributors. The volume contains twenty-six papers in all, most of them from Germany and Holland, but there are a few from England and two from America.

Thus was celebrated the first quarter of a century of activity of this most brilliant man. The history of men of science has few such records.

Harry C. Jones.

Chemical Laboratory,
Johns Hopkins University,
February 2, 1900.

THE MEETING OF NATURALISTS AT CHICAGO.

In response to a call issued December 8, 1899, and signed by Professors C. R. Barnes, H. H. Donaldson, S. A. Forbes, W. A. Locy and Jacob Reighard, about thirty naturalists of the Central States met at the Hull Biological Laboratory, on Thursday and Friday, December 28th and 29th. Among those present, in addition to the Chicago naturalists, were Professors Burrill, Kofoid and Smith, of the University of Illinois; J. G. Needham, of Lake Forest; H. V. Neal; of Knox College; Birge, of Wisconsin; Lee, Nachtrieb and Sigerfoos, of Minnesota; H. L. Osborne, of Hamline University; Nutting, of Iowa; Eigenmann, of Indiana and Reighard and Jennings, of Michigan. Professor Donaldson presided at all the meetings and at the dinner.

Thursday morning and Friday morning and afternoon were devoted to the reading of papers. Twenty-five titles were announced; but five of these were omitted through the absence of the naturalists who announced them or through lack of time. Thursday afternoon was devoted to a discussion on 'Methods and Results of Limnological Work.' Professors Birge and Kofoid opened the discussion, in which Professors Reighard, Nachtrieb, Eigenmann, Osborn and Davenport also took part. The papers of Professors Birge and Kofoid follow this report. On Thursday evening a dinner was held at the Quadrangle Club, and was attended by thirty persons. After the dinner the question of organization was considered. Since the American Society of Naturalists simultaneously meeting at New Haven had neither rejected nor adopted the proposition that a branch or section of the American Naturalists should be authorized to hold meetings in the Central States, but had appointed a committee to consider the matter, it was decided not to organize. A committee consisting of Professors Rieghard, Locy and Nachtrieb was instructed to nominate five naturalists who should have charge of all arrangements for a second meeting and should report at that meeting recommendations for a permanent organization and for the establishment of relations with the American Society of Naturalists. The committee subsequently elected consists of Professors Birge, President; Barnes, Lee, Nutting and Davenport, Secretary.

Abstracts of the papers read at the meeting follow:

Townet collecting at Cold Spring Harbor, Long Island. CHAS. P. SIGERFOOS.

During the summers of 1898–99 fairly complete records of townet collecting were kept at the Laboratory of the Brooklyn Institute. Cold Spring Harbor is so far from the open sea that larval and other transitory pelagic forms are never, perhaps, swept in by winds and tides from the outside. This is an advantage in many cases, because it enables the collector to say that certain forms found there live, thrive and breed locally.

As elsewhere, the day collections are less varied and abundant than those made in the night-time. In the former are present the medusæ of various hydroids (*Podocoryne*, *Bougainvillea*, *Perigonimus*, *Obelia*, etc.); ctenophores (*Mnemiopsis*) in all stages; starfish larvæ; pelagic fish eggs; and many other forms found less frequently or especially at night. In the night-time there are present, in addition to the above, great numbers of copepods (mostly of a species of *Acartia*), many of its individuals parasitized by *Apoblema*; larvæ, in various stages, of *Squilla*, decapods and other crustaceans; adult *Diastylus*, *Mysis*, *Gammarus*, etc.; the larvæ of various molluscs (*Ostrea*, *Crepidula*, *Bulla*); and many other forms found less frequently. One of the most interesting finds consisted of a few specimens of tornaria larvæ, apparently belonging to an undescribed species of *Balanoglossus* found at Cold Spring Harbor.

On the motor reactions of Flagellata and Ciliata. H. S. JENNINGS.

Previous work had shown that the aggregations of Paramecia in certain chemicals, in regions of optimum temperature and the like, as well as their avoidance of certain agents, are due to a motor reflex of essentially the same character as the motor reflexes so well known in higher organisms. This reflex consists in swimming, when stimulated, toward a structurally defined end and turning toward a structurally defined side, whatever the nature or position of the stimulating agent. The paper presented a study of a number of flagellates and ciliates, to determine whether such a motor reflex is common. It showed that *Chilomonas*, *Euglena*, *Loxophyllum*, *Colpidium*, *Microthorax*, *Dileptus*, *Loxodes*, *Prorodon*, *Stentor*, *Spirostomum*, *Bursaria*, *Oxytricha* and some others respond to many stimuli by a reflex essentially similar to that of *Paramecium*. It seems probable therefore that the so-called chemotaxis, thermotaxis, tonotaxis, and the like of these groups of organisms are in general, as in *Paramecium*, produced through such a reflex. Whether this reflex plays a part in phototaxis, electrotaxis and geotaxis has not been shown. The paper showed also that many of these organisms are much more sensitive at their anterior ends than elsewhere on the body, and brought out a number of facts in regard to the reactions to localized stimuli.

Notes on the occurrence of Uroglena in the Lafayette water supply. SEVERANCE BURRAGE, Purdue University.

Uroglena is one of the organisms that has become of interest to engineers and biologists on account of the disagreeable oily or fishy taste and odor imparted by it to water supplies. It is apt to occur in the clearest and purest waters. The Lafayette supply is derived from driven wells in the bed of the Wabash river, and before reaching the reservoir is a most excellent and inoffensive water. This reservoir, however, being uncovered, furnishes an admirable opportunity for the growth of any organism. It seems probable that several small ponds—so-called lakes—that lie within a few hundred feet of the reservoir, serve as culture beds for the *Uroglena*, and the reservoir may become inoculated by means of birds and other agents. *Uroglena* may be found in some one of these ponds at almost any time. The Lafayette reservoir was infested with this organism in the late summer and early fall of 1896, and it has reappeared quite regularly ever since, in the warm weather. The species of *Uroglena* occurring here corresponds fairly well with *U. Americana* (Calkins), as described in Massachusetts State Board of Health Report, 1891.

It was not the purpose of the paper to bring out any new facts in regard to the organism *Uroglena*, but merely to record its rather regular appearance in Lafayette.

Remarks on a series of wax-models, illustrating cleavage stages in Crepidula. Thomas G. Lee.

The models shown were made by Mr. B. Eric Dahlgren, one of Dr. Lee's students, at his laboratory at Minneapolis. Mr. Dahlgren seems especially fitted to do this sort of work, if there is a demand for it.

Spermatogenesis in Hybrid pigeons. M. F. Guyer.

Hybrid pigeons exhibit several abnormalities in spermatogenesis. These are most marked in the sterile hybrids. In such, the first thing to strike the attention is a curious bead-like varicosity about the middle of the spermatozoön head. In the development of such spermatozoa the nucleus does not elongate completely, as it does normally, to form the head; consequently, at one point there remains a sort of vesicle corresponding in position to the original nucleus before the ends pushed out to form the long head. Some of the sterile birds showed also a marked degeneration of the germinal cells. In some cases no spermatozoa were matured and many of the cells had degenerated. Often deeply-staining masses of protoplasm each with a large central vacuole were present. In both sterile and fertile hybrids there was much variation in cell division. Inequalities in chromatin distribution were common and multipolar spindles, abundant. The nuclei of the spermatogonia contained sixteen chromosomes, which is the regular number. In normal primary spermatocytic there are eight large ring chromosomes, each apparently being equivalent to two of the spermatogonial type, but in the hybrids there were often more than eight. Sometimes there were as high as sixteen small rings, in which case a doubling of the chromosomes had evidently not occurred. When sixteen chromosomes were present in the spermatocytes they were usually located on two spindles, eight to a spindle. Frequently both large and small rings were present. These peculiarities in chromosome formation may point perhaps to a tendency in the chromatin of each parent species to retain its individuality. If such is the case, then in those cells with two spindles each bearing eight chromosomes, it is evident that after division, some of the new cells will have chromatin from only one of the original parent species and some, from the other. Some of the spermatozoa, therefore, will bear chromatin from one only of these species. It is a well-known fact that the offspring of hybrids are extremely variable, a portion of these variations being usually in the form of reversions to one or the other of the parent species. The possibility presents itself then, that this reversion may be due to the persistence of the chromatin of only one species in one or both of the germ cells. Carrying the conception still further, the other variations in the offspring of hybrids may be due, perhaps, to the varying proportions of the chromatin of each species in the mature germ cells.

The egg of the Stichostemma. C. M. CHILD.

During the autumn of 1899 a species of *Stichostemma*, probably *S. asensoriatum* Montgomery, was found in great abundance in a park lagoon in Chicago. In this small fresh-water nemertean, the gonads occupy the position usual in nemerteans, *i. e.*, between the diverticula of the intestine. The animal is hermaphroditic and probably more or less completely protandric, though spermatozoa are often found in the same gonads with ripe eggs. The gonad is in the form of a follicle, which is lined with the germinal syncytium. The portion of the syncytium which is to form the egg, containing one nucleus, bulges out into the cavity of the follicle and grows in size so that the follicle is filled. It remains attached to the remainder of the germinal mass by a pedicle, and yolk spheres are formed not only within the limits of the oöcyte itself but also in the protoplasm about the pedicle. As the oöcyte grows, the greater portion of the germinal protoplasm appears to pass into it and all or nearly all of the germinal nuclei disappear leaving a single oöcyte in the gonad. Sometimes two oöcytes instead of one are formed in one gonad. The growing oöcyte forms a membrane about itself, but the stalk remains until the egg is laid, when it is broken off and the membrane, which swells rapidly under the action of water, closes over this portion of the cell also. Thus the oöcyte does not become a distinct cell until the moment of laying.

The pore of the gonad is apparently not preformed, appearing at the time of laying. As it is very small the egg is greatly deformed in its passage, but its protoplasm is so fluid that it flows out easily, in a fine stream, all except the nucleus, which often appears to block the way for a moment and then pops out suddenly. After laying the egg soon assumes a spherical form and the membrane swells to a considerable thickness. Eggs are laid normally in strings somewhat less in length than the body of the worm, and containing two rows of eggs in a considerable amount of slime secreted by the skin, and attached to plants, etc.

Self-fertilization may occur (probably occurs normally in many cases) and is followed by normal development. Almost immediately after fertilization the whole surface of the egg becomes roughened in consequence of ectoplasmic activity, and soon accumulations of liquid appear between the egg and the membrane. Various changes of form occur during the formation of the two polar bodies, and, the vitelline membrane being absent, amœboid processes of the ectoplasm appear at many points. Soon after their formation the polar bodies begin to enlarge and become transparent, and before the first cleavage is completed they have usually disappeared. In the manner of their degeneration they resemble very closely injured or unripe eggs which die in the water. These increase in size very rapidly and become vacuolated and soon the yolk becomes liquid and disappears.

Just before and during the first cleavage pseudopodia-like outgrowths of the ectoplasm are abundant in the region of the cleavage-furrow. The ectoplasm is clearly continuous between the cells.

In the resting two-cell stage, again in the four-cell stage, and between adjacent cells in subsequent stages temporary cavities appear which are filled with liquid. These increase in size and finally collapse, often opening distinctly to the exterior. The next division begins almost immediately after their collapse. The excretion of fluid during maturation and fertilization, the tendency to vacuolation of the protoplasm observable in the polar bodies and injured eggs and the accumulation of fluid in temporary intercellular cavities during cleavage are probably, as Kofoid suggests concerning similar phenomena in pulmonates, etc., connected with life in fresh water. The cleavage is spiral.

Concerning Cotylogaster occidentalis sp. nov. Preliminary notice. W. S. Nicherson.

An American representative of the trematode genus *Cotylogaster* occurs in the Mississippi valley parasitic in the 'sheepshead.' The animal is from 8–10½ mm. long. The anterior proboscis-like part of the body is terminated by a five-lobed disk surrounding the mouth. The ventral surface bears a compound sucker composed of from 132–144 acetabula of which from 31 to 34 form a median longitudinal row of transversely elongated grooves; the remaining 100–110 are in a single row surrounding the median series. These are rounded or elliptical in outline and not definitely arranged with respect to the members of the median row. Marginal organs are present.

From the dorsal surface near the posterior end rises a broad conical elevation. The excretory pore is at the base of this cone between it and the posterior margin of the sucker. The genital aperture is median, in front of the margin of the sucker. A penis is lacking: the testes are two in number posterior to the ovary. The ovary is smaller than the testes and on the left of a median plane. The shell gland is anterior to the ovary, diffuse. The vitellaria are a pair of elongated laterally placed cords of tissue. The eggs are numerous, spheroidal, destitute of yolk cells. When discharged they contain a fully formed embryo with unforked intestine and simple subterminal sucker at posterior end. The body of the embryo is covered in part by a simple epithelium bearing distinct tufts of cilia.

Studies in Earthworm Chlorogogue. W. J. Rice. Read by title.

A demonstration of slides illustrating the Compound Oösphere of Albugo bliti, as published in the Botanical Gazette, September and October, 1899. F. L. Stevens.

The simultaneous mitoses of the oögonial nuclei, the multinucleate oösphere and antheridial tube, the extrusion of many male nuclei into the oösphere, the fusion of the male and female sexual elements in pairs to form about fifty fusion nuclei as well as the new cell organ, the *coenocentrum* were abundantly illustrated by slides. The peculiar feature of this work lies in the fact that while this species presents a compound oösphore and a multiple fertilization, other related species seem to show only a simple oösphere and a simple fertilization.

Gametes and Gametangia of the Phycomycetes. B. M. Davis. Read by title.

Suggestions toward a classification of plant societies based on topographic development. H. C. Cowles. Read by title.

The early stages of development of ventral nerves in Cyclostomes and Selachians. H. V. Neal, Knox College.

Problem—Is there a difference in the modes of development of ventral nerves in the lower and the higher vertebrates? Investigators differ in their results. Observations on embryos of Squalus and Petromyzon preserved and stained by the raw Roth-Pyrogallic acid method have given some positive results, while such methods as the Golgi, Gold Chloride, Corrosive Sublimate, Palladium Chloride and others fail in the early stages when the nerves are first formed. The raw Roth-Pyrogallic acid method is advantageous in staining deeply cell boundaries and axis cylinder processes in early stages. The results obtained by the use of this method are: 1. Ventral nerves in Squalus and Petromyzon embryos arise primarily as axis cylinder processes of cells lying in the ventral horn of the neural tube. 2. There are secondarily added to these processes cells from two sources: (*a*) cells which have migrated out from the neural tube in the region of the root of the nerve; and (*b*) cells from the mesenchyma through which the nerve passes. At first these cells take a peripheral position with reference to the bundle of axis cylinder processes (= nerve fibers), but in later stages they migrate into the midst of these processes. 3. The cells thus added secondarily to the nerves do not form nerve fibers as has been held by several investigators, but form simply the primitive or Schwann's sheath. The nerve fibers are from their beginnings the processes of cells lying in the ventral wall of the neural tube as stated above. The mode of development of the medullary sheath has not been determined.

Thus the ventral nerves of these Anamniote forms differ in their development from the same nerves in Amniota only in deriving some of the sheath cells from the neural tube. The sheath cells in Amniota appear to be derived wholly from the mesenchyma (His, Kölliker and others).

The conclusions of Balfour, von Wijhe, Dohrn, Beard, Kupffer and others, that cells migrate from the neural tube into the ventral nerves of Amniote embryo is thus confirmed. The inference that these cells form the nerve fibers is not correct.

On the existence of accessory optic vesicles, based on new observations. W. A. Locy. Read by title.

New observations on the primary segments of the vertebrate head. Charles Hill.

This was presented by Dr. Locy.

The development of the adhesive organ and hypophysis in Amia. Jacob Reighard. (In conjunction with Miss Phelps and Mr. Mast.)

An account of the development of the adhesive organ appeared in the report of the New York meeting (1898) of the American Morphological Society, published in Science. The hypophysis develops as an ectoblast thickening connected with the anterior neuropore and lying, in early stages, between the neuropore and adhesive organ. Its subsequent history does not differ essentially from that described for other vertebrates by Haller. It is at no time connected with the entoblast, and unlike the hypophysis of Acipenser, does not, therefore, afford support to Kupffer's interpretation of the hypophysis as a paleostome.

Exhibition of figures for a Normentafel of Amia with an account of methods of photographing the embryo. Jacob Reighard.

The method consists in the use of a long focus lens (80 mm. projection lens of Leitz), together with a long camera—the large photomicrographic camera of Zeiss—attached to the wall vertically. This arrangement allows of great focal depth, together with a magnification of 10–20 diameters. The microscope stands on a base-plate provided with leveling screws. Focusing at a distance is accomplished with a device which works the coarse adjustment. Reflectors for regulating the intensity of the shadows and a means of marking the embryo in order to obtain a sharp focus were described.

The breeding habits of Amia. Jacob Reighard.

The nests are premeditated structures and are prepared sometime in advance of spawning by the male fish, by biting or tearing away the bottom vegetation. They are not accidental, or mere concomitants of the act of spawning. They may be near or remote from one another according to the character and extent of the available bottom. Spawning is intermittent and usually covers a period of several hours.

Notes on a Dakota Axolotl. H. L. Osborne.

A new *Axolotl* was found in March, 1899, in Amenia, North Dakota, an occurrence farther north than heretofore known. The body proportions are those of an *Amblystoma.* Its total length is 312 mm. It possesses the following larval characters different from previously known *Axolotls*: (*a*) a dorsal fin beginning on the level of the second body ring, 8 mm. high, running around the abdomen to the cloaca; (*b*) a smooth area of the skin on each side of this in the dorsal region; (*c*) a skin beyond the smooth area in the trunk region minutely warty-roughened, and marked with scattered circular dark spots; (*d*) eyes located one-fifth of the distance from the angle of the mouth to the origin of the third gill; (*e*) the longest of the three gills as long as the head; (*f*) the gills all broadly spatulate and flattened and the margin divided distally. The following characters of the adult are present: (*a*) all the four limbs are completely formed; (*b*) the lungs are fully developed; (*c*) the oviducts are much enlarged and filled with eggs ready for deposition. Characters of the skin, the size and form of the gills distinguish it from either the Mexican form or from the *Siredon lichenoides* of Baird and Girard from New Mexico.

The degeneration of the eyes of the cave Salamanders. C. H. Eigenmann.

Will be published shortly in full in Science.

The arrangement of the single and twin cones in the retina of fishes. C. H. Eigenmann.

Will be published shortly in *The American Naturalist.*

Notes on the Natural History of Polyodon. C. A. Kofoid.

In the Illinois River and its adjacent waters, *Polyodon* is pelagic in habit. Its food is typical plankton, chiefly Entomostraca and the larger Rotifera and Protozoa, with no evident admixture of bottom rubbish or sedentary organisms. In swimming the mouth is held wide open, without the rhythmical respiratory movements common in most fishes, though it is occasionally closed energetically. The plankton is thus strained from the water by the long gill-rakers, and *Polyodon* is a living plankton net. The fish was never observed to use the bill to stir up the bottom or in any mechanical way. It quickly perceives plankton or ground fish added to the water of the tank, and, when feeding, circles repeatedly over the same path, at times dragging the lower fins upon the bottom. The bill isabundantly supplied with sensory structures and serves as an expanded sense organ and not as a mechanical aid in feeding.

On Platydorina caudata. C. A. Kofoid.

This new genus of the Volvocidae has been found in the Mississippi, Illinois and Wabash basins in summer and fall months. It consists of a plate of 16 or 32 similar biflagellate cells arranged in a horse-shoe shaped cœnobium, which bears at its posterior end 3 or 5 tails formed of the matrix and sheath. The two faces are exactly alike, alternate cells upon either face presenting the flagella to the surface. The plate is slightly twisted in a left spiral and the rotation of the colony in locomotion is predominantly from right over to left. The polarity of this genus is the most pronounced in the family being structural as well as physiological. The two transverse axes are also established though their poles are not differentiated. Asexual development is similar to that of *Eudorina* with a subsequent flattening of the ellipsoidal cœnobium and an intercalation of the cells of the two sides. Sexual development not known.

Variation in the sea anemone Sagartia Luciæ. GERTRUDE C. DAVENPORT.

Sargartia Luciæ is conspicuously marked by a varying number of orange colored bands which run longitudinally. These orange bands were counted in 751 individuals at Cold Spring Harbor. Their number varied from 0–20. The largest proportion had 12 stripes. Secondary maxima occurred at 8, 4, 1 and 16. Longitudinal division was observed in which the twelve stripes were apportioned to the two resulting individuals as follows: 9–3; 4–8; 5–7. Also such divisions as 3–3; 7–1 were noted. Hence the variation in the number of stripes is dependent upon fission. Division, so far as observed, was aboral-oral and was usually accomplished within of 24 hours. By feeding to repletion, division already begun could be delayed, even apparently prevented. When cut longitudinally into halves regeneration was rapid. Even small fragments artificially obtained reproduced normal individuals. Normal division was observed only in diglyphic types. Monoglyphic individuals are plentiful and occur as the result of division of diglyphic forms. Basal budding and fragmentation are believed to be very common method of multiplication of this species.

Variation studies on Pectinatella magnifica. C. B. DAVENPORT.

The number of spines on the statoblasts of *Pectinatella* from Chicago was counted in over 800 cases. The law of distribution of frequencies was deduced by quantitative methods. The skewness is positive, that is there is an excessive tendency toward large numbers. This fact of variation in the form-unit agrees with the fact that the other races of *Pectinatella magnifica* and the other species of the genus have a larger modal number of spines. The ontogenetic causes of the variation and of abnormalties was considered.

C. B. DAVENPORT.
Secretary.

SOME OF THE PROBLEMS OF LIMNOLOGY.*

IF the object of science is to correlate and state the results of observation in such a way as to produce mental economy, it can hardly be said that limnology has developed very far as a science. It is certainly still true that much of our knowledge regarding lakes is in that condition of detailed statement whose mastery involves great mental exertion. Through this stage all sciences have passed and signs are not lacking that limnology will soon reach the position now occupied by older branches of biological science. To secure this result the student of lake life must attempt to solve problems rather than merely to state facts.

Two classes of problems present themselves to the limnologist: the first, scientific; the second, practical. The first comprises the problems raised by the study of the lake as a unit of environment. The second class concerns itself with the question of the lake as a unit of economic production. The answer to the practical question depends on the correct solution of the scientific problems.

In attempting to solve these problems the limnologist finds himself constantly hampered by the lack of knowledge through which he may interpret the results which he reaches. The acquirement of this knowledge seems to me the first and most necessary step toward bringing exactness and comprehensiveness into our views of lake biology. We count the constituents of the plankton, but are not able to state the significance of the results which we reach. Laborious and slow as the process of counting is, I see no escape from the conclusion that it will remain for a long time the only exact way of ascertaining the facts regarding the assemblage of plants and animals which constitute the plankton. For the

* Address in opening discussion on 'Methods and Results of Limnological Work,' at the meeting of Naturalists at Chicago, December 28, 1899.

interpretation of these results more knowledge is necessary. I shall content myself with pointing out a few directions in which this interpretative knowledge must be gained, if the results of observation are to be of real scientific value. First in importance I should place the knowledge of the chemistry of the plankton, from which its possible nutritive value can be learned. The unit system of counting, as advocated by Whipple, is undoubtedly a great advance on mere enumeration, but the units thus employed are not even units of mass, much less units of chemical composition. The difference in the amount of ash between diatoms and crustacea, not to speak of other differences, is so great that no direct comparison, however exact, of cubic contents can teach us the significance of the two groups in the lake's plankton. Chemical analyses only will do this and these must be be stated both in terms of bulk of the centrifuged or settled plankton, and in terms of the average individual plant or animal, as determined by counting. Every limnologist, therefore, should be careful to avail himself of the opportunity presented by the appearance of a monotypic plankton to collect it in sufficient quantities for analysis. I have myself to confess that I have neglected three opportunities of collecting *Daphnia hyalina* in these large quantities. Similar opportunities have no doubt been neglected by many of us, but the necessity of this information is so pressing that I am sure we must all agree in placing it first on the list of desiderata.

It may be possible to collect the ordinary plankton in large quantities and to separate it into its constituents more or less completely by means of one of the centrifugal milk separators. The difference in density between the diatoms, the cyanophyceæ and the crustacea is so great that there ought not to be any serious difficulty in separating the plankton into at least three groups. So far as I am aware, no experiments have been made in this direction, but the work must be attempted and in some way or other we must secure single groups, or, if possible, single species of plankton plants or animals in quantities sufficient for chemical analysis, or our results will continue to suffer from their present indefiniteness.

A second line of investigation which demands much study concerns the biological significance of the constituents of the plankton, especially of the plants. Many observers have noted that certain algæ are eaten more freely by the crustacea than are others, yet no such careful and continued observations have been made as to enable us to make any general statements on the subject. Evidently, however, this work must be done, or even the chemical knowledge gained by analysis will fail to disclose the real interrelations of the plankton plants and animals.

A third point of equally great importance concerns our knowledge of the chemistry of the water of the lakes and of its gaseous contents as related to the plankton. Many waters have been analyzed, yet few or no attempts have been made to correlate these analyses with the nature and abundance of the several plankton species. Still more conspicuously is this true of gas analyses. We suppose, for instance, that in certain lakes the accumulation of the products of decomposition in the deeper waters prevents the animals of the upper regions from descending into the cooler waters of the lake, yet we are at present entirely ignorant of the nature of these products, whether they are gaseous or other, and of the way in which they are able to affect so powerfully the biological conditions of the sub-thermocline. Numerous similar questions are pressing for solution.

A fourth class of questions comprises those raised by the relation of the littoral area to the limnetic region of the lake.

We may be sure, however, that these questions will be very slowly answered, since they open the most complex questions of lake life and those most difficult of solution. We know enough already to be confident that general statements regarding the relation of littoral and limnetic regions are very unsafe. It is true that lakes with steep banks are plankton-poor, yet it does not follow that lakes with large littoral areas are correspondingly rich in plankton. It certainly is not true that lakes are poor in plankton in proportion to their depth, so that even these most simple relations between the shore regions and the deeper water require careful and extended study in order that any safe conclusions may be drawn.

I have contented myself with pointing out a few of the directions in which limnology needs to move if the stock of facts which limnologists are accumulating is to receive an adequate interpretation. In order that such a result may be reached in the future, it is necessary for the student of lakes to propose to himself definite questions and to work as definitely toward their solution. The time has passed when the publication of the limnetic species, or even the quantitative determination of the constituents of plankton can materially further the advance of science. This work was useful, chiefly in disclosing to us the problems of limnology. These are now before us, in part at least, and the time has come when the student of lakes must attempt to answer some of them.

E. A. BIRGE.
UNIVERSITY OF WISCONSIN.

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*A PRELIMINARY ACCOUNT OF SOME OF THE RESULTS OF THE PLANKTON WORK OF THE ILLINOIS BIOLOGICAL STATION.**

THE Illinois River drains an area of 29,000 square miles, is over 500 miles in length, and has at low water a fall of but 31 feet in the last 227 miles of its course. The low gradient is due to the fact that, in a part of its course at least, the present stream and its bottom lands occupy the bed of an ancient outlet of Lake Michigan. The present flood plain is but partially developed—the bank height rarely exceeding 15 feet—and overflows are frequent and extensive. Floods rise from 16 to 24 feet above low water levels, increasing the total extent of water area to over 700 square miles. The impounding action of the bottom lands, the low gradient, and the backwater from the Mississippi River combine to prolong the flood period. The stream at low water is from 500 to 1500 feet in width and three to 12 feet in depth, and by reason of the dams forms a series of slackwater pools with a sluggish current of about one-half mile per hour. The waters of the adjacent lagoons, bayous, and lakes are also shoal and attain a high temperature during the period of summer heat. The water is rich in organic matter being derived from the run-off and seepage of fertile prairie soil and is further fertilized by the sewage of a metropolis and of a score of smaller cities along its banks, in addition to the offal of extensive cattle-yards and large amounts of distillery wastes. Under these conditions it is not surprising that ammonia, nitrites and nitrates are present in excessive quantities. The high temperature and the abundance of nutrition thus favor the development of the aquatic flora and in sequence that of the aquatic fauna.

Quantitative investigations of the plankton have been carried on at somewhat regular and frequent intervals from June, 1894, to April, 1899, in a series of representative localities near Havana, Ill.; (1) the main stream; (2) Spoon River, a typical tributary; (3) Quiver Lake, rich in vegetation much of the time and fed by spring water; (4) Thompson's Lake, a large (6 × .5 miles) open lake, fed by the river and usu-

* Abstract of address in opening discussion on Methods and Results of Limnological work at meeting of Naturalists at Chicago, December 28, 1899.

ally free from vegetation; (5) Phelps Lake, an ephemeral body of water without vegetation; (6) Flag Lake, a large swamp, choked with vegetation, rarely drying up in the summer. At times of high water all these localities are submerged. The quantitative and qualitative examination of the collections, as yet incomplete, indicate the following more or less tentative conclusions:

1. The waters contain a typical fresh-water plankton, that is, one composed of limnetic organisms usually cosmopolitan and identical with or closely related to the plankton organisms of larger bodies of water. It has much in common with the plankton of German streams, and at low water is remarkably like that of the Nile at a corresponding stage. The admixture of littoral forms in the open water of the lakes and in the river is surprisingly small in the number of individuals, though presenting a considerable range of species. In all about 500 different species have been found, of which at least one-third may be called limnetic.

2. There is a marked seasonal variation in the amount of the plankton. A spring maximum, usually in May or June, follows the winter minimum and is in turn followed by an apparent mid-summer minimum in August. An autumn maximum of secondary importance precedes the return to the winter minimum. These statements are based, as usual, upon catches made with the silk net and are subject to the error arising from the leakage of the smaller organisms through the silk. The correction of this error by supplementary methods tends to eliminate the summer minimum and to augment the autumn maximum. The volume of plankton in the spring maximum is from 20 to 50 times that of the winter minimum. These fluctuations are repeated from year to year, but vary in time of appearance, in extent, and in relative development in successive years and in different waters. Irregular fluctuations also of great extent may occur in any locality especially during the summer and fall.

3. There is a marked seasonal variation in the organisms composing the plankton. During the winter minimum the chlorophyll bearing forms are relatively few, the plankton being composed of a few hibernal and a smaller number of perennial species principally of Rhizopoda, Copepoda and Rotifera. The presence of ice on the surface, and the low temperature of the water (0°–4° C.) do not interfere with the growth and reproduction of this winter plankton. Fouling of the water by an excess of sewage under the ice may, however, exterminate the animal life of the water. As the temperature rises, the brown flagellates and the diatoms increase in number and subsequently the green flagellates and other chlorophyll-bearing organisms multiply rapidly. This is accompanied by a marked development of animal forms, especially Cladocera and Rotifera, resulting in the spring maximum. This culmination is rarely due to the excessive development of a single species, but is typically polytonic. A rapid decline of the vernal species, principally Entomostraca and diatoms, produces the midsummer minimum, characterized by the relatively small number of individuals, and the very large number of species, principally Rotifera and the smaller green flagellates. The autumn maximum appears after the equinoctial rains and is often composed in large part of Synchæta, Synura, and diatoms. This is also the period of maximum numbers of the ciliate Protozoa. The total number of species in the fall plankton is not large and the predominant forms are few.

No two years present throughout the same sequence of species in the same relative numbers. In some instances, species abundant in one year have not been found or have occurred but sparingly in other years. As a rule the numbers of individuals and their seasonal range are alike subject to considerable fluctuations from year to year. The qualitative differences in the plankton from season to season are due to the adaptations of different species to different seasonal conditions, especially in the matter of temperature, and the differences from year to year are perhaps to be correlated with the fluctuating environment.

4. At times of high water all plankton stations at which examinations have been made are in one continuous body of water, and the plankton is quite similar throughout, especially in spring floods. As the water recedes and the several lakes and the river emerge as distinct units of environment, the planktons are very quickly differentiated by the disappearence of certain species and the multiplication of others as seasonal changes progress, so that in a few weeks each locality presents its own peculiar assemblage of organisms. This phenomenon is repeated from year to year and occasionally several times in one year, depending on the fluctuations in the river levels. The different localities examined thus present at times of low water great local differences in the amount and constitution of the plankton, corresponding to contrasts in the environment, especially in respect to vegetation, source of water and temperature. The assemblages of organisms characteristic of a given locality, though varying somewhat, present many points of similarity from year to year.

5. Waters in which aquatic plants, such as *Ceratophyllum*, *Elodea*, *Naias*, *Potamogeton* and *Nymphœa* are abundant, are, in the localities examined, as a rule poor in plankton. The removal of the vegetation by wind and flood or by fishermen's seines is followed by an increase in the amount of plankton. The same lake may then be plankton-rich one year and plankton-poor the next, according to the amount of vegetation it contains. The phyto-plankton thus apparently replaces the coarser aquatic flora.

6. The local distribution of the plankton in lakes with somewhat uniform conditions of bottom, water supply, and vegetation is remarkably even, in so far as the volume of the plankton is concerned, the variation from the average falling within the 30 per cent. observed by Apstein in the lakes of northern Germany. The distribution of many species is far less uniform. In the river, except near the mouths of large tributaries the distribution of the plankton is even more uniform than it is in the lakes, the variation in the amount of the plankton from shore to shore is less than 10 per cent. Under even conditions the amount of plankton in the current of the river ($\frac{1}{2}$ to $2\frac{1}{2}$ miles per hour) varies but little from hour to hour and day to day—being often within 10 per cent. and rarely exceeding 20 per cent. at one point of observation at Havana. Catches made at intervals of 10 miles in the lower 220 miles of the river show a considerable uniformity in amount and constitution, except where modified by local conditions such as sewage on tributary waters.

7. The plankton of tributary streams is relatively very small in amount and is composed of a different assemblage of organisms. The immediate effect of tributary waters is to dilute the plankton. The river is thus a unit of environment with its own peculiar fauna and flora.

8. Flood waters quickly and profoundly affect both the amount and the composition of the plankton, diluting it and washing it rapidly away toward the sea and to a slight extent replacing it with the more or less sessile forms torn away by the current of the creeks and of the river itself. The silt of flood waters is often disastrous to many species of Entomostraca. The recovery in the volume of the plankton after floods is

usually rapid, the chlorophyll bearing organisms, especially the green flagellates appearing first, followed in turn by the animal plankton, Protozoa, Rotifera and Entomostraca. The resubmergence of the bottom lands doubtless starts anew encysted forms left by receding waters. In general the recovery from the flood culminates in a plankton maximum of greater or less importance, depending upon the season of the year and the extent of the flood.

9. Species present in great numbers are often extremely variable, as for example, *Brachionus bakeri*. The varieties are often local, or seasonal, but may also be coëxistent. Variation is often very great in the case of species reproducing parthenogenetically as the rotifer just mentioned, in other rotifers, in Daphnia and in Bosmina.

C. A. Kofoid.

MALARIA AND TUBERCULOSIS.*

The visit of certain English physicians to Italy during the Christmas vacation, was in some respects so remarkable as to make a full description of it of general interest. Commendatore Florio, a wealthy and beneficent citizen of Palermo, invited certain English physicians first to Rome, in order to see the work done by their Roman brethren in the investigation of malaria; and, secondly, to Palermo, to inspect a sanatorium for the cure of consumption which Commendatore Florio has erected under the advice of Professor Cervello, of the University of Palermo. The party of English physicians with their friends was about twenty in number, among them being Sir T. Lauder Brunton, Sir Walter Foster, M.P., Professor Clifford Allbutt, of Cambridge, Dr. Manson, C. M. G., and Dr. Cantlie, of the London Tropical School. Dr. Malcolm Morris and Dr. St. Clair Thompson represented the National Association for the Prevention of Tuberculosis, and Dr. Gibson represented Edinburgh. They were received at Charing-cross Station by Commendatore Florio's representative and travelled with him to Rome, where they remained for some days in conference with Professors Grassi, Bignami, Celli, and Bastianelli. Signor Grassi, now Professor of Zoology in the University of Rome, is a Sicilian, and while a professor at Catania carried out the remarkable researches on the propagation of the eel which secured for him the Darwin Medal of the Royal Society.

Professor Grassi, since his removal to Rome, has performed work perhaps no less remarkable in demonstrating the propagation of malaria. This story is not only so interesting in itself, but of such vital importance to our own colonies, some of which are desolated by malaria, that I will try to sketch briefly what will be told in full by Professor Grassi in an illustrated volume to appear very soon both in Italian and English. A few years ago M. Laveran won a place for himself on the distinguished roll of Frenchmen of science by discovering in the blood of malarious patients a minute parasite, a form belonging to the humblest order of animal life. Three different but closely allied species of parasite are severally concerned in the causation of the three kinds of malarial fever. M. Laveran's researches were fully verified by observations both in Europe and in America, and further observations made of their behavior in man. Certain suggestive facts led Dr. Manson to suspect that a gnat or gnats were the means of propagating the parasite, and, having himself returned from the tropics, he pressed Major Ross, then of the Indian Medical Service, to follow up this clue in India. Himself an ardent engineer and now chief of the Liverpool Tropical School, Major Ross set to work with some success, but unfortunately his efforts were impeded by

* From the London *Times*.

the active discouragement of his official superiors in India. Thus hampered he was able, nevertheless, to ascertain that a gnat (a culex) is the means of propagating a malaria in birds but not, as it turns out, any one of the malarial parasites of man. At this point the Roman physicians took up the subject, Professor Grassi on the side of zoology, Professor Bignami of pathology, Professor Celli of prevention. Their researches have proved, and Major Ross has since verified their statements in West Africa, that malaria in man also is propagated by a gnat, but not by a culex; the enemy of man is a dapple-winged gnat, scientifically known as *Anopheles claviger*. Professor Grassi showed to his visitors a large number of beautiful drawings illustrative of the anatomy of this gnat, and of the life of the parasite within it. The gnat, in sucking the blood of an infected man, takes in the parasite; this in a spheroidal form may be demonstrated in the stomach of this fly, and its course, followed closely as it penetrates the walls of the stomach, reaches the juices of the body, as a tiny worm-like creature, and thus wriggles onwards into the salivary (or poison) gland of the insect, whence it is again returned to man by the proboscis. Thus between man and the anopheles these parasites maintain their cycle of life. No man, and no dapple-winged gnat, no malaria.

Not the least interesting part of the visit was the excursion with the professors into the Campagna, where two farms had been selected for experiment. In the one protection was given against the access of the insects; in the other no such precautions were taken. Other things were equal; in the former farm was no malaria, in the latter malaria prevailed as before. Fortunately *anopheles* rarely bites men on the move; secreting itself in their cabins or chambers it attacks them while at rest—especially at night, when by certain apparatus its inoculations may be avoided. Whether *anopheles* can be extirpated or not is a large and difficult question. This gnat breeds in pools of a certain kind, not quite stagnant, but supporting confervæ (Limna), on which its larvæ subsist. From such pools these larvæ were collected and exhibited in abundance to the visitors. A small spoonful of common petroleum oil will destroy all the larvæ in a square yard of such water, and it seems possible, therefore, that by drainage, where possible, and the supplementary use of oil the insect might be removed from large areas. In turning up new ground such pools are apt to form and breed the gnat, a result which might be avoided by no very difficult provision. By his generous invitation Commendatore Florio has enabled skilled English observers to verify these invaluable researches—researches into the minute habits of very obscure creatures which will have nevertheless a very large effect upon the well-being of man in fertile tracts of the world now too pestiferous for continuous occupation, at any rate, by white men.

The cure and prevention of tuberculosis has of late years excited the public interest more than of malaria, of which fell disease our home population now happily knows little. From Rome Commendatore Florio's guests were taken to Palermo, and were entertained in the Villa Igiea, the exquisite palace, for I can call it no less, in which consumptive patients are to be received and treated on the open air system, with all advantages that a beautiful and uniform climate, a lovely site, and every luxury of life can give. The sanatorium, which will be completed in a few months and then opened by the King and Queen of Italy, is built outside Palermo upon the rocks on which the deep sea of the bay actually beats. In the clefts of these sunny rocks are marble benches, temples and grottoes, and about their sinuous margins winds terrace upon terrace broadening up to the plateau on which, some forty yards from the sea, the sanatorium stands, sheltered behind to the north by the mass of Monte Pellegrino. Of this great and splendid curehouse, Professor Cervello is the physician in chief, and Baron Fassini, whose charming qualities as a host endear him to his guests, is the director. The most perfect modern systems of cure have been studied in Germany and elsewhere by Professor Cervello, whose dietetic regulations will be rendered less oppressive by the ministrations of a first-rate French chef, and whose draughts of fresh air will be administered to those who desire it in a beautiful yacht of 300 tons, which is always to be at the call of the patient. In Palermo Commendatore Florio himself, the Messrs. Whittaker and other residents did their utmost by brilliant hospitality and constant kindness to make the visit of the English physicians and their friends a memorable one; and not the least delightful of their memories will be that of the sanatorium and its grounds illuminated by myriads of lamps and hundreds of men with torches as they steamed away from the harbor on the night of their departure.

It is urged on behalf of the Villa Igiea that Palermo is the nearest place to the Continent of Europe where so delightful a climate is to be had, where there are so many resources for quiet cheerfulness and so much charm for the eye and imagination. But it is needless to add that residence in a fairy place, with a French cook and a yacht at command, can be no cheap cure. The sanatorium when finished will accommodate about 100 patients, who must necessarily belong to the wealthiest class of society.

In respect of finance I must add that Commendatore Florio did not issue his generous invitation with any eye to commercial advertisement. He has built the Villa Igiea with no intention of personal profit; after providing a fund for repairs and contingencies, all surplus is to be set aside for building a sanatorium or sanatoriums for the poor. He was also wishful that English physicians should see at work a method of inhalation of the vapor of formaldehyd which Professor Cervello believes will prove a very valuable ally in his treatment of pulmonary phthisis. This method the Professor has used for some time in the consumption wards of his hospital with, as it appears to him, satisfactory results. Whether this method turns out to be valuable or not, and this time only can show, there can be no doubt even now that the Villa Igiea offers incomparable advantages as a sanatorium for the modern system of cure of the most grevious of all pests of man.

SCIENTIFIC BOOKS.

Social Laws. An Outline of Sociology. By G. Tarde. Translated from the French by Howard C. Warren, Assistant Professor of Experimental Psychology in Princeton University, with a preface by James Mark Baldwin. New York, The Macmillan Company. 1899. Small 8°. Pp. xii + 213.

This little book consists of a collection of lectures delivered by M. Tarde at the *Collège Libre des Sciences Sociales* in Paris during the month of October, 1897. The French edition appeared in 1898 under the title, *Les Lois Sociales; Esquisse d'une Sociologie.* It has now come forth very opportunely in an English dress, which enables those who do not keep a close watch for important contemporary foreign literature to acquaint themselves with the views of one of the leading thinkers of our time. It does not claim, as the author is at pains to say, to give a summary of his three principal works, The Laws of Imitation, Universal Opposition, and Social Logic, but rather to show what there is in common in these works, and how they together constitute a system of social philosophy.

There is one respect in which Tarde may be compared with Malthus. Each, in studying man and society, arrived at a biologic law applicable to both man and the organic world below man. There is, however, this difference, that while Malthus discovered a law of biology that had not as yet been recognized by biologists, Tarde has discovered a law well known to biologists, but scarcely as yet recognized as a law of sociology. Another difference is that the Malthusian law, while it holds universally in the animal world and is true of man as an animal, is not true of rational man, having been superseded by the law of mind, which has inaugurated a new dispensation; whereas the Tardean law, if we may so speak of it, is as true of the rational man as of the animal man and the animal, and, broadly interpreted, takes in the inorganic as well as the organic world. This Tarde has perceived, and he expresses it in this book in the following words: "The time has come when it would be in place to set forth the general laws governing imitative repetition, which are to sociology what the laws of habit and heredity are to biology, the laws of gravitation to astronomy, and the laws of vibration to physics" (p. 61). Nor is this the first time that he has said such things. Sweeping comparisons of the kind are frequent in the works named. We may refer especially to the footnote on page 37 and the discussion on page 159 of the second edition of the *Lois de l'Imitation*.

What, then, is this Tardean law? Most readers have become familiar with the five leading terms of Tarde's philosophy: Imitation, Repetition, Opposition, Invention, and Adaptation. The one most dwelt upon is *imitation*. Next to this *invention* has come to be recognized as having been given a special meaning by Tarde. We read less about *repetition* and *opposition* in their new rôles, while *adaptation* scarcely receives any amplification at Tarde's hands.

First, then, as to *imitation* as a social law. That men have always imitated one another, especially in what they deemed good, is, of course, well known, but it had not been perceived that this is the basis of all custom, of all morals, and of the social order. Imitation is specially characteristic of the lower races and of the higher animals. The first of these facts is a common remark of travelers and ethnographers. The second is attested by language itself, the word for *ape* in most languages being that for mimicry. In the development of mind imitation is the natural and necessary precursor of imagination, and all early art consists in mere copying. Who has not noted the slavish conventionalism of aboriginal and even civilized art patterns? Below the psychic plane and in the simple world of life, the homologue of imitation is clearly *heredity*, *i. e.*, reproduction of what already exists. But this is only transmission from one body to another. The same process is going on within the organic body. Here it takes the name of *nutrition*, and growth itself is a form of imitation. Below the life plane and throughout the inorganic world something very similar takes place. Here it is simply *impact*, producing motion, and the physical homologue of imitation is *causation*. Imitation is the universal conservative principle of nature.

Repetition is included in imitation. It is the mechanical effect of which imitation is the physical cause. It results whether the force behind it be psychic, vital, or physical. It is therefore rather an accessory term expressing the necessary consequence of imitation than a new coördinate fact in Tarde's system.

Opposition is the resistance with which the effort to repeat, reproduce, and perpetuate constantly meets from the impinging environment. It is, as Tarde says, 'universal.' In human society it embraces not only the conflicts with the elements and with wild beasts, but the far more formidable conflicts among races and nations—*bellum omnium contra omnes.* It is also oppression and revolution, monopoly and competition, and the strife of capital and labor. In the organic world it is nothing short of the universal 'struggle for existence,' so clearly set forth by Darwin. In a word, it represents the environment. In the physical world it is the innumerable obstructions in the path of every moving body, producing collisions and arresting, deflecting, constraining, and transmuting motion.

Invention is the first step in advance. It is not universal, but appears sporadically. It is well described by Tarde in the following passage: "Social transformations are explained by the appearance, to a certain extent accidental as regards time and place, of certain great ideas, or rather by a considerable number of ideas, small or great, easy or difficult, usually unperceived at their origin, rarely brilliant, generally anonymous, but ideas always new, and which, by reason of this newness, I will allow myself to baptize collectively as *inventions* or *discoveries*" (Lois de l' Imitation, p. 2).

Invention breaks away from the bonds of imitation. Instead of exact repetition and reproduction of the old pattern it adds something, however little, to it, and this in the direction of improvement. This is a permanent gain, because the improved state immediately becomes in turn the subject of imitation. The word invention is given the greatest possible latitude. It embraces everything that departs in the least from the strict line of exact reproduction and perpetuation of the existing type. A thousand causes lead to it. Tarde has not worked these out as well as he might. Necessity may have been the primordial mother of invention as a condition to further existence. But with the growth of mind a certain degree of nonconformism naturally arose. The obstacles to the satisfaction of desire (opposition) bred discontent and induced efforts to overcome them. Mind is the naturally aberrant element in the world, and deviations from the straight path of custom resulted. At long intervals, few and far between, even as now, the inventors, *i. e.*, the innovators, made their appearance, with the results described by Tarde.

What, now, is the relation of invention to imitation and opposition? It is the product of the joint action of both of these. We saw that imitation and repetition constitute causation in the domain of thought and ideas, also in that of life. They are the *force* at work in these fields. They are the *causa efficiens*, the *vis a tergo*, that propels the vital and psychic worlds. As such they obey the Newtonian law, and the motion resulting is in straight lines. Cause and effect are in intimate contact, and this repetition, or rectilinear motion is simply continuance, *i. e.*, *continuity*. But opposition interferes with this, tends to arrest motion, constrains and transmutes it. So far the process is *genetic*. But mind is *telic*. It is a *final cause*. It was developed as a means of overcoming opposition, of surmounting obstacles, of avoiding resistance, and of circumventing counter-forces, in order to attain foreseen ends. This is the essence of invention, which is therefore born of the repetitive *nisus* in conflict with the obstructive environment, *i. e.*, of imitation and opposition.

As invention seems to be wholly the product of the higher mind and late in origin, it might be supposed that, unlike imitation, repetition and opposition, it would have no homologue in the animal world or on the plane of mere vital existence, and still less in the field of purely physical phenomena. Not so, however. Just as in the organic world, heredity is the homologue of imitation, and environment is the homologue of opposition, so *variation*, the product of heredity and environment, is the homologue of invention, the product of imitation and opposition. Dropping now into the physical world, where, as we saw, causation is the homologue of imitation, and collision is the homologue of opposition, we see that the product of these is *evolution*, which is therefore the true cosmic homologue of invention.

Adaptation, as the final great social law, is perhaps more fully treated in this little book than in any of Tarde's previous volumes. He devotes the third and last chapter to it, occupying 58 pages of the English text. And yet this is the least satisfactory part of Tarde's system thus far. This is not because it is not equally important, but because it is not set forth with anything like the originality and power that characterize his treatment of the other great laws. This is perhaps partly because he found the field thoroughly worked over by the biologists, and there is so little new in sociological adaptation. But he says justly that adaptation "expresses the profoundest aspect under which science views the universe." He perceives that it is a progressive coördination of social phenomena, and in a sense a synthesis of repetition and opposition, just as in biology it is a development as the result of a synthesis of heredity and environmental resistance. But he does not work out the mode of operation of this law in a way analogous to that in which Darwin worked it out in biology, nor does he give us the sociological equivalent of natural selection, philosophically expressed by Herbert Spencer in the phrase 'indirect equilibration.' Adaptation is an indirect social equilibration, the complete analysis of which remains to be made. Tarde, indeed, dwells on the fact that adaptation consists in a certain harmony and unity in the social world, from which it is clear that he sees the dependence upon it of the social order. Between adaptation and invention, in Tarde's wide use of both terms, we have an antithesis which in its essential aspects is the same as the antithesis between order and progress. It is just here that sociology naturally falls into the two great subdivisions of social statics and social dynamics.

It may be objected to the above analysis that it does not follow closely enough the method of the work under review, and that it goes back to the author's other works and even lays the conceptions of other authors under tribute. But this could scarcely be avoided in anything beyond pure exposition. As a matter of fact very little is said in this book of the great law of invention. But how could this be avoided in any glance at his system? The aim has been rather to summarize that system and present it as a whole, while laying special stress, as Tarde claims to do in this work, on the relations that the leading laws sustain to one another. But the system is a large one. It is thoroughly elaborated in a long series of books, and different readers may see many things very differently. Again, the excessive condensation necessary to a short review compels the omission of so many important things that no claim is made to having done justice to that system.

The English text forms a neat and convenient little volume, printed in clear type and tastefully brought out. The translation is free and the original is rendered in elegant English without obscurities or gallicisms. In a few cases it is open to the charge of being just a little too 'liberal.' Only one such need be referred to. On page 168 the original: "Et ce cas tend à se généraliser par les progrès de la machinofacture," is rendered by: "And this sort of case tends to become more general with the improvements in the manufacture of machinery." Aside from the fact that this does not convey the idea of the original, there is certainly a loss in avoiding the word *machinofacture*. This is a word of Tarde's special mintage, struck off with all due reserve in a footnote to page 174 of the *Logique Sociale*, and freely used thereafter, often as here, without italicizing, on the assumption that his readers now understand it. But it is as good English as French, and while in both languages the word *manufacture* has lost its literal implication of *handmade*, and embraces machine-made products as well and for the most part, still it was a fine stroke to call attention by this new term to the primitive form of industry, and to emphasize in one word the enormous stride that industry has taken, which, with all its blessings, is at the same time the fundamental cause of the chief socio-economic problem of modern times.

LESTER F. WARD.

Die Conchylien der patagonischen Formation. Von H. VON IHERING. Mit 2 Tafeln. *Neuen Jahrbuch für Mineralogie, Geologie und Palæontologie.* Jahrg. 1899. Bd. II. (S. 1–46 Taf. I., II.).

In this paper Dr. von Ihering has made an important addition to the invertebrate paleontology of the Patagonian beds. The paper is based upon a collection of invertebrate fossils recently made by Mr. C. Bicego of the Sao Paulo Museum, from the typical Patagonian beds at the mouth of the Santa Cruz river in southern Patagonia. According to Dr. von Ihering about 50 species are represented in the collection. Among these are nine new to science and some three or four new varieties.

Not the least important features of Dr. von Ihering's paper are the geological questions discussed in it. Following Dr. Ameghino, von Ihering considers the Patagonian and Supra Patagonian (Santa Cruz) beds, as quite distinct and proceeds to set forth at some length the paleontologic and lithologic features which according to him are characteristic of each. Happily we have here for the first time a definite locality given where the Patagonian beds may be observed in their typical development and exhibiting those lithologic and paleontologic features, which, according to Dr. von Ihering, distinguish them from the Supra Patagonian beds. This alone is a most important point, since it gives us a definite base from which to start in a comparative study of the Tertiary formations of Patagonia, as they are understood by Drs. von Ihering and Ameghino. It is to be hoped that the latter author will also, in the no distant future, realize the importance of giving at least some one definite locality at which each of the various geological horizons (Mesozoic and Tertiary) that have been named by him at various times may be found and studied. It is alone by such frankness, which should characterize the work of naturalists everywhere, that we shall be able the more easily to arrive at a true solution of the age and relations of the various geological formations of Patagonia.

According to Dr. von Ihering (see page 4 of his paper), the fossil shells of the Santa Cruz (Supra Patagonian) beds are usually enclosed in a soft, sandy matrix, while those of the Patagonian beds are firmly imbedded in very hard clay stones. Dr. von Ihering does not contend that these conditions are absolute throughout the two series, but that the former prevails in the upper series while the latter predominates in the lower. He also finds the faunas of the two deposits to be quite distinct. On pages 6 and 7 he gives a list of 67 species as belonging to the Patagonian beds. He finds only 16 of these 67 species in the Santa Cruz (Supra Patagonian) beds. On page 38 he gives a number of genera and species which according to him are characteristic of the Santa Cruz (Supra Patagonian) beds.

Regarding the lithologic characters given by Dr. von Ihering, it should of course be remembered that he has himself never visited Patagonia, and has therefore to rely upon the nature of the matrix adhering to the fossils and the reports of Mr. Bicego, whose observations in southern Patagonia have been limited to the region about the mouth of the Santa Cruz river. But even in that locality Mr. Bicego certainly could not have failed to observe that the lithological conditions given by Dr. von Ihering, as prevailing in the Patagonian beds, are in reality, of extremely limited extent when compared with the entire thickness of fossil-bearing rocks at this locality. There are, as Dr. von Ihering says, many instances of hard clay-stones or other concretions literally filled with the shells of mollusca, and occasionally a stratum of hard sandstone, which is also fossilliferous. The superior resistance which such materials offer to erosion are apt to mislead the not too careful collector as to their relative importance, and with such material at hand, and to be had only for the picking up, he is likely to overlook many of the real gems which will richly reward the collector if he turns to the several hundred feet of soft sand and clays and examines them *in situ*. On weathering away, however, the usually soft delicate shells are reduced to powder and rendered worthless. If Mr. Bicego had occasion to examine the bluffs along the south side of the Santa Cruz river, between the village of Santa Cruz and Direction hill at the mouth of the river, he must have seen numerous shell layers in the soft crumbling sands and clays, which constitute by far the greater portion of the 350 feet of sediment exposed in the bluffs. A notable example of this is to be seen in the bluff of the river about one and a-half miles above Direction hill and just above where formerly stood the temporary observatory erected a few years ago by the United States Steamer *Brooklyn* (?). At this point the bluffs rise directly from the river and there is a continuous stratum of loose sand, filled with shells. This stratum is about six inches thick and a quarter of a mile in length. It is located at a height of only five to ten feet above high water and can scarcely fail to attract the attention of anyone passing along the foot of the cliff. At various altitudes above it, other similar shell-bearing layers may be seen in the same bluff. At Direction hill and along the coast to the southward are many other strata of soft materials rich in fossils, while if any one will take the trouble at low tide to walk out over the surface of the beach he will frequently see the soft tosca literally filled with fossil shells. In one soft stratum near the mouth of the river the writer found a bed about eight inches thick and 20 to 30 feet in length, composed almost entirely of the shells of *Struthiolaria ornata*, which according to von Ihering is characteristic of the Patagonian beds, mingled with a few specimens of *S. Ameghinoi*, which, according to the same author, is found only in the Supra Patagonian (Santa Cruz) beds. Moreover, there are a number of blocks of the hard matrix from the mouth of the Santa Cruz river and now in our collections in the museum, mingled together in the same block are to be seen various species, some of which, according to von Ihering, are characteristic of the Patagonian and others of the Supra Patagonian (Santa Cruz) beds.

Dr. Ortman, who is making a thorough study of our collections of Tertiary invertebrates from Patagonia, is entirely unable, from the list of species given by Dr. von Ihering (page 38), as characteristic of the Patagonian and Supra Patagonian (Santa Cruz) beds, to refer any of the numerous horizons from which our collections have been made to either the one or the other series of beds, on account of the mingling of these alleged characteristic species. He finds represented in our collections from the typical Patagonian beds at the mouth of the Santa Cruz river all but one of the genera and species given by von Ihering (p. 38) as characteristic of the Supra Patagonian (Santa Cruz) beds. This one exception (*Voluta ameghinoi*) he finds in our collections from the Mt. of Observation associated with *Cardium puelchum*, *Cardita patagonica* = *inæqualis*, *Siphonalia noachina*, which according to von Ihering are characteristic of the Patagonian beds.

Of the sixty odd species given by von Ihering (pp. 6–7) as coming from the Patagonian beds, Dr. Ortman is able to at once designate thirty-five of them as occurring in our collections associated with one or more of the characteristic species of the Supra Patagonian (Santa Cruz) beds as enumerated by von Ihering (p. 38), while every single one of the latter species has been found with von Ihering's characteristic Patagonian species. It will thus be seen that it is clearly impossible to distinguish these two formations by their faunas, while the lithologic characters are even less distinctive. Nevertheless there are in certain instances decided lithologic and faunal differences at the various localities, and it sometimes happens that such differences are quite marked even in the same actual horizon and at neighboring localities. To such local differences due to the varying conditions attending the deposition of the beds, is due the confusion regarding their stratigraphic relations. Before making more extended observations, the present author like Drs. von Ihering and Ameghino, was in favor of considering these beds as composed of two distinct formations. Subsequent observations, made at many different localities, have convinced me, however, that the Patagonian and Supra Patagonian beds do not represent distinct time intervals, but that sedimentation was continuous from the base to the top of the series, and that the strata of which they are composed all belong to one formation (the Patagonian formation). The rocks composing these beds were laid down, as the fossils clearly indicate, either in a shallow sea or as littoral deposits. The shallow sea deposits constitute the Patagonian phase of the series, while in the Supra Patagonian phase are included the sands and muds that were accumulating simultaneously along the shores and smaller estuaries as their included fossils clearly indicate. The Patagonian phase prevails at the base and the Supra Patagonian at the top of the series, but neither is restricted to any definite horizon within the limits of the entire series.

On page 29, Dr. von Ihering enters upon a discussion of the age and relative position of the various sedimentary formations of Patagonia, giving a review of the conflicting opinions expressed at different times by various authors on these questions. He also points out the erroneous ideas formerly held by Dr. Ameghino regarding the relative, stratigraphic position of the *Patagonian*, *Supra Patagonian and Santa Cruz beds*. In this general *résumé* he has fallen into an error regarding the position taken by myself in a former paper with reference to the stratigraphic position and age of the *Pyrotherium beds* of Ameghino. Since others, more especially Drs. Ameghino and Roth, have also misunderstood the position taken by me at that time on this question I shall improve the present opportunity to explain a little more fully my views concerning the Pyrotherium beds. I did not, as these authors seem to think, place the Pyrotherium beds above the Santa Cruz beds. I placed them in the Cretaceous, where according to Ameghino they belonged.

I did, however, seriously question both their Cretaceous age and the stratigraphic position assigned to them by the Ameghinos. From a study of Dr. Ameghino's description of the mammalian fauna found in them, I advanced the opinion that there were mingled together in the so-called Pyrotherium fauna, representatives from two or more distinct horizons. This opinion Dr. Ameghino has since admitted to be a fact and has separated his Pyrotherium beds into two distinct formations which he separates by a long time interval. My succeeding two years of field-work in Patagonia have further convinced me as to the correctness of my former views regarding the *Pyrotherium beds.*

In referring on page 30 to the paleontologic evidences advanced by myself regarding the age of the Pyrotherium beds, Dr. von Ihering is quite right in saying that the tooth mentioned and figured by myself as belonging doubtfully to Pyrotherium, is a tooth of Astrapotherium, and also in maintaining that in the process of development of any mammalian phylum, certain organs may early attain a considerable degree of specialization, while the animal as a whole remains quite primitive in its structure. Everyone I presume will readily grant this, but would Dr. von Ihering have us entirely overlook the extremely close relationships, brought out on almost every page of Dr. Ameghino's papers on the Pyrotherium fauna, as existing between the so-called Cretaceous fauna of the Pyrotherium beds and that of the Santa Cruz beds, which latter are now known to be not older than Miocene? Many of the mammals described by Ameghino from the Pyrotherium beds are scarcely specifically distinguishable from allied forms in the Santa Cruz beds. In a few instances Ameghino has himself admitted that he can not distinguish forms from the Pyrotherium beds from well-known Pliocene and Pleistocene animals. Among such may be noticed the large gravigrade edentate which he is unable to distinguish from Mylodon, more than likely for the very good reason that it is a tooth of Mylodon from thePleistocene deposits that occur throughout the greater part of Patagonia.

Considering the highly specialized character of the Pyrotherium fauna and its remarkably close relationship as a whole to the Santa Cruz fauna, in connection with what we already know of the character of the stratigraphic work of the Ameghinos in Patagonia, the Cretaceous age of the Pyrotherium beds can no longer be seriously considered. Moreover the stratigraphic observations of Dr. Roth, Señor Mercerat and myself are all at variance with such a position for them.

On page 45 Dr. Von Ihering includes the Cape Fairweather beds in the Tehuelche formation as is also done by Ameghino. If I mistake not the term Tehuelche formation was proposed by Doering for the great bowlder or shingle formation of Patagonia. Unfortunately I have never been able to see Doering's paper. If I am correct in this the Cape Fairweather beds should not be included in the Tehuelche formation since they are quite distinct and unconformable as I have been able to observe at several different localities. The Cape Fairweather beds are Pliocene while the Bowlder formation is unquestionably Pleistocene. A curious account of the relations of these two deposits has been published by Dr. Ameghino in the *Geological Magazine*, for January, 1897. On page 17 in speaking of these two series of beds he says, after quoting at some length from a letter from his brother, Charles Ameghino: "According to this the bowlders were deposited at the bottom of the sea and over them there extended at other periods a vast formation of marine shells." In this instance Dr. Ameghino has again reversed the true stratigraphic relations as he did for many years with the Patagonian, Supra Patagonian and Santa Cruz beds.

J. B. Hatcher.

Geological Survey of Canada. By George Mercer Dawson, C.M.G., F.R.S., etc., Director. Annual Report. (New Series.) Vol. X. Ottawa, December, 1899.

This volume, comprising 1046 pages of text accompanied by eight maps and illustrated by twelve plates and a number of figures in the text, has just been issued by the Department and forms publication No. 679 of the Catalogue of volumes published by the Canadian Survey. It is addressed to the Hon. Clifford Sifton, M.P., Minister of the Interior, and contains many valuable reports of exploratory and geological surveys, both in the little known districts of Canada, as well as in the densely populated and older provinces of the Dominion of Canada. The volume opens with a 'Summary Report of the Operations of the Geological Survey for 1897,' by the Director.

This report describes the various publications issued during the year, the geological information on the Yukon District, Museum and office work, and also the result of boring operations in Northern Alberta. The Director also gives reports of explorations and surveys in British Columbia, Manitoba, Ontario, Quebec, Hudson Strait, New Brunswick and Nova Scotia. It is followed by Mr. W. McInnes's report 'On the Geology of the Area covered by the Seine River and Lake Shebandowan Map-Sheets,' in the gold-bearing series of Northern Ontario. The Laurentian, Couchich and Keewatin Steep Rock series, and Animikie series of rock formations occurring in that district are described and their contacts carefully noted. The localities which are productive and of economic value receive special attention and notes on the glacial geology are also included. This forms Report II. of the volume.

'Report on the Area included by the Nipissing and Temiscaming Map-Sheets,' by Mr. A. E. Barlow, forms Report I. of this volume, and comprises 302 pages of text, including two appendixes: (1) 'List of Elevations'; (2) 'On some Cambro-Silurian and Silurian Fossils from the Lake Temiscaming, Lake Nipissing and Mattawa Outliers,' by Henry M. Ami, of the paleontological staff. Mr. Barlow's report forms a very complete study of an important area of archæan rocks, in which he has described the main geological features with a great deal of pains, and gone into details of the composition of the gneisses met in the *Laurentian* of the area in question, together with their petrographical relations; also in the 'Grenville series' as developed and recognized by him in that district.

The *Huronian* system is then discussed, and the breccia-conglomerates, the diabase and gabbro and granites met with carefully described, along with their relations to the post-Archæan eruptives. He then devotes the succeeding chapters to a description of the Cambro-Silurian, Silurian and Pleistocene areas included within the two maps of the district examined, and has a chapter on 'Economic Geology' describing the valuable deposits of gold, silver, nickel, copper, iron and other minerals occurring there. Regional descriptions follow, which will prove of great value to prospectors and miners in a district, full of beautiful lakes and waterfalls and magnificent scenery, and holding economic minerals of untold wealth.

Report J, by Mr. R. Chalmers, 'On the Surface Geology and Auriferous Deposits of South-eastern Quebec,' contains upwards of 160 pages of very valuable reading and illustrations, with statistics of the gold production of the Beauce and Chaudière River region of Quebec. The pleistocene marine shore-lines, the rivers and lakes, the denudation that has taken place, together with the action and products of the Appalachian glacier, the Laurentide ice, and that of the local glaciers, as well as of floating ice, are all discussed. The gold-bearing region is then described. This includes the history of mining in the Gilbert River, River du Loup, Famine River, Mill River, Slate Creek, Main Chaudière Valley, Little Ditton River, etc. The probable source of the alluvial gold is then given by the author.

'The Mineral Resources of New Brunswick,' by Professor L. W. Bailey, forms Report M of this volume and is a most welcome report. This province ought to receive as well as give more attention to the materials of economic value, which occur in the earth's crust as it is developed in that portion of the Dominion of Canada by the sea. The geological formations, in which iron, copper, nickel, antimony, lead, silver, manganese, coal, bituminous shales, graphite, peat, gypsum, granites, marbles, dolomites, ornamental stones, infusorial earths, mineral springs, and various other materials of economic value to man are to be found, are described, and the mode of occurrence of these useful materials given, together with their locations. A map of the minerals of the province accompanies the report.

Report S contains the customary and useful report of the 'Section of Mineral Statistics and Mines,' by Mr. E. D. Ingall. It contains upwards of 200 pages of valuable notes on all the economic minerals of Canada from all the provinces, and tables of their value and of the amount produced and exported or consumed at home.

The volume contains a very complete index, which adds greatly to its value.

H. M. AMI.

North American Slime Moulds. By T. H. MACBRIDE. New York, Macmillan & Co.

The appearance of this book must be gratifying to all American students of the slime moulds. It is gratifying also that it comes from the pen of one who has long been identified as an ardent student of these lowly organisms, and whose former contributions to the literature of the subject have shown signs of a conscientious student. It follows closely after the appearance of two monographs covering the species of a much wider geographical area and including the American forms; the one by Mr. George Massee of the Kew Herbarium, London, Eng., and the other by Mr. Arthur Lister, of the British Museum, London, Eng. Nevertheless, it will be found convenient for American students because it is limited to American species, and especially because the author has had an opportunity of comparing a larger number of specimens representing the American species, than perhaps were accessible to the monographers mentioned above.

Each of these three authors arrives at a different conclusion after the usual course of reasoning in the selection of the name for the entire group. Massee uses the name *Myxogastres* first applied by Fries in 1829. Lister employs the name *Mycetozoa*, given by de Bary, in 1858, which included the *Acrasieæ* of recent discovery and the *Myxogastres* of Fries. MacBride choses the name *Myxomycetes*, substituted by Link in 1831 for Fries *Myxogastres*, but emended by deBary to include the exosporous species, the endosporous species only having been treated of by Fries and Link. The *Myxomycetes* of deBary thus formed a subdivision of his *Mycetozoa*. The author then says (p. 13), "Myxomycetes (Link) de Bary must remain the undisputed title for all true slime moulds, endosporous and exosporous alike."

In the introduction the author briefly describes the habits and morphology of the organisms. It is evident from his discussion on page 9 et. seq., that he considers them to be plants. But he very sensibly recognizes the difficulties here presented by a group of organisms, whose vegetable characteristics on the one hand ally them to the amœboid animals, and on the other hand give rise to no higher group. He says "it is purely a matter of indifference whether we say plant or animal, for at the only point where there is connection there is no distinction." There are given directions for the collection and care of material, and also is given a good bibliography.

In the taxonomic part of the book, the *Myxomycetes* (Link) de Bary are regarded as a class which is divided into three sub-classes. The first sub-class is the *Phytomyxineae* Schroeter, with one species, *Plasmodiophora brassicæ* which produces the common club foot of cabbage, turnips and other cruciferous plants. The second sub-class, the *Exosporeæ* Rostafinsk, includes two species, the well known *Ceratiomyxa fruticulosa* (*Ceratium hydnoides*) and *C. porioides*, which may be only a variety, or form, of the first named, as suggested from material collected by the writer at Ithaca, and indeed Lister considers it a variety only (Mycetozoa, p. 26). The third sub-class the *Myxogastres* (Fries) MacBride, represents the *Myxomycetes* properly speaking, and it is here that the large number of genera and species are to be found. 'Keys' are given first to the orders of which five are recognized. Then under each order are given keys to the genera and species, with synonymy and diagnoses, which latter are further made lucid by copious notes in most cases. The distribution of each species as at present known to the author is also given.

In his treatment of the nomenclature the author has not been led into many very painful upheavals of antiquated names, though in several cases the species appear under unfamiliar names, the most notable being *Mucilago spongiosa* for *Spumaria alba*. Forty-four genera are treated and over two hundred species. These are illustrated by eighteen excellent plates. The work is published in the attractive way so characteristic of many of Macmillan's books.

GEORGE F. ATKINSON.

CORNELL UNIVERSITY.

BOOKS RECEIVED.

L'Année biologique. YVES DELAGE. Paris, Schleicher frères. 1899. Third year, 1896. Pp. xxxv + 841.

The Theory of Electrolytic Dissociation and some of its Applications. New York, The Macmillan Company. 1900. Pp. xii + 289. $1.60.

The Psychology of Religion. EDWIN DILLER STARBUCK, with a preface by WILLIAM JAMES. London, Walter Scott; New York, Charles Scribner's Sons. 1900. Pp. xx + 423.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF BIOLOGY.

THE regular meeting was held on January 8, 1900, Professor F. S. Lee presiding.

Mr. David Griffiths spoke of the structure of certain species of the *Sordariaceæ* and briefly reviewed the work which has been done on the group. Certain species were taken as types of the principal genera, and their life history traced, *Sordaria finicola*, *Podospora coprophila*, *Hypocopra equorum* and *Sporormia intermedia* being spoken of especially. Some time was devoted to a discussion of the much mooted question of fertilization in this and kindred groups. The principal methods of spore distribution were outlined.

Dr. Wm. J. Gies reported upon the changes which may occur in lymph after the administration of protoplasmic poisons. Quinin did not interfere with the usual influence of dextrose although it did suppress the action of leech extract. The results with dextrose, therefore, indicate that the increase in the quantity of lymph following its injection in large quantity is due mainly to physical factors. In the case of leech extract, on the other hand, there is an interference with the action of the physiological factors that appear to be responsible for the changes usually brought about by this lymphagogue. That the increase in the amount of lymph after large quantities of dextrose have been injected is not due primarily to increased capillary pressure, as is held by Cohnstein and Starling, was shown in one of the experiments in which quinin caused the death of the animal, and yet from which the lymph continued to flow for three hours. After injecting arsenic, which is said to very greatly increase the permeability of the blood vessels, especially those of the portal system, there was little in the flow and character of the lymph resembling the usual effect of lymphagogues. It appears, therefore, that Starling's hypothesis of increased capillary permeability does not fully account for the action of lymphagogues, and that the mechanical theory of lymph formation fails as long as it does not explain the most striking phenomena of the process—those following the injection of Heidenhain's lymphagogues or Asher's 'liver stimulants.' The physiological theories of Heidenhain and Asher would explain them.

Professor Frederic S. Lee said that the duration of the life of voluntary muscle in mammals after the death of the individual has not been well known. Under the author's direction, Messrs. Adler and Bulkley have been investigating this in cats and rabbits. In each experiment the animal was killed, a particular muscle was excised and stimulated by electric shocks at five-minute intervals, and the resulting contractions were recorded. The muscles used were the *soleus* (deep red), and the *tibialis anticus* (pale). Each survived several hours, the maximum for the red muscle being 14 hours and 37 minutes, and for the pale, 12 hours and 20 minutes. It is known that, in comparison with white muscle-fibres, red fibres contain relatively more sarcoplasm, which is nutritive in function, and relatively less fibrillar substance, which is the contractile part. This may perhaps account for the longer survival of the red muscle. So far no constant difference in duration has been observed between the cat and the rabbit. In both the red and the pale muscle the decrease of irritability was gradual, but occasionally in the *tibialis* there was a sudden fall at the end of about one hour, the irritability then continuing at a low ebb for hours but with a gradual decline. The sudden fall may have been due to the early death of the white fibres, which intermingled with red ones, occur in the pale muscle. Besides the theoretic interest, the above results have a practical bearing, since they show that mammalian muscle can readily be used for experimental purposes in the physiological laboratory. This is now being done at Columbia University.

Professor Henry F. Osborn reported upon

recent additions to the American Museum from the Cope collection through the munificence of President Jesup. (For a fuller account see SCIENCE, N. S., XI., p. 77.)

Bashford Dean described the condition in seven eggs of *Myxine glutinosa* which he had received from Professor A. E. Verrill. These had been collected in 1880 on the Newfoundland banks in water of 90 and 150 fathoms. The egg membranes were regarded as more specialized than those of Bdellostoma.

FRANCIS E. LLOYD.
Secretary.

DISCUSSION AND CORRESPONDENCE.

DO THE REACTIONS OF THE LOWER ANIMALS AGAINST INJURY INDICATE PAIN SENSATIONS ?*

IN a posthumous article with the above title by the lamented Professor Norman is contained the chief substance of what was to have been his doctorate thesis. It comprises new facts and a statement of those that are old in a way which will interest especially the psychologists and gratify to no small degree the physiologists—or some of them. While the author answers the titular question in the negative, as his main thesis, 'lower animals' indicates for him only those species up to and including the flounder. Moreover, the paper is remarkably free from opinions based on analogy, the evidence being weighed as its author thinks solely for what it is worth and regarding the particular species experimented upon alone.

The report begins with a proper adverse criticism of that mode of argument in a circle which bases presumption as to the mode of consciousness concomitant to movements, on these same movements taken as expressive of certain modes of consciousness. He follows rather the purely physiological method of considering movements as the immediate consequence of physical stimulation, the psychic factor not entering the problem at all. Certain experiments seem to the author to prove the correctness of this point of view.

* By the late Professor W. W. Norman, University of Texas, with Additional Note by Jacques Loeb. *American Journal of Physiology*, Vol. III., No. VI., 1 Jan., 1900. Pp. 270–284.

The most striking and classic of these experiments were made on the common earthworm (*Allolobophora*). If such a low animal be divided at its middle transversely, only the posterior half shows those squirming and jerking movements which, anthropomorphically viewed, seem to indicate pain; the anterior half (containing the brain) crawls, as ordinarily, away. Now if each of these halves be halved, again the posterior segment of each squirms while the anterior halves crawl away. This same process may be continued with precisely like result until the pieces are no longer large enough to crawl independently. This striking phenomenon is explained in part by the two sets of muscular fibers in the worm, one longitudinal, causing the squirming and jerking, and the other circular, which produce the crawling. Why in the posterior segments the former set should be initially stimulated and in the anterior the latter set, Professor Norman says he does not know. For its purpose the experiment seems conclusive. Similarly, if a swimming leech be cut in two, both parts, after a pause, swim off as if nothing had happened. Like events take place with other species of worms, the anterior or brain part being regularly that undisturbed by the extraordinary stimulus.

The abdomen of a hermit crab may be cut in two without any 'but a very slight response' from any remaining movable organ. *Limulus* stops a few seconds when four or five abdominal segments are cut away, then proceeds quietly breathing as before. Its order of events is regularly: cessation of breathing, flexion of abdomen, pause, extension of abdomen, respiratory movements. *Geophilus* cut in two in the middle continues its crawling, the front half going forwards and the rear half backwards. Millipedes divided while walking do not hasten nor stop nor jerk. Dragon flies lose parts of their abdomens without any appreciable change in position. As was long ago pointed out, bees continue to eat when their abdomens are cut way during the process.

Lastly, sharks and flounders, provided a current of water circulate through their gills, will allow the most tedious and deep-going cutting operations on their heads without the slightest appreciable movement indicative of pain or even of sensation.

In the 'additional note,' Professor Loeb points out as the two chief results of the investigation: "(1) In a great number—perhaps the majority—of lower animals injuries cause no reaction which might be interpreted as the expression of pain sensations. (2) In the limited number of cases where injury is followed by motions which have been considered as the expression of pain sensations (as in the case of worms) a closer analysis shows that this interpretation is unjustified."

This article is noteworthy not least for what it neither says nor implies, namely, that animals other than those there considered probably do not feel pain. Notwithstanding this most commendable modesty of opinion on the part of its author, certain considerations present themselves therefrom, which are of too great moment both to psychology and to physiology to remain unanswered. The problem may be properly considered as insoluble—yet well worthy of debate. It will not be maintained that these animals do experience pain when they are injured, *but only that they may for all that experiments prove to the contrary.* Analogy and reasonable presumption are our only methods when inexperiencable sensations are in question and the former of these at least works both ways.

The lowness of the investigator's subjects in the animal 'scale' is worthy of preliminary notice. On this account it would at first sight seem that the author's and Dr. Loeb's opinion was more valid, on the common supposition that 'so low a grade of consciousness could not include actual, stinging pain.' The nervous systems of these worms and echinoderms and fishes seem undoubtedly too simple to allow of the presence of organs for pain such as on the whole seem probable in man and his congeners. The highest, highly differentiated animals require painful sensations as a means teleologically protective of their different organs; in the lowest orders, on the other hand, this need does not exist, for their relative simplicity of plan makes possible the regeneration of any lost part or organ or even the perfecting of an individual from a part artificially cut off from another individual. It is therefore extremely reasonable even from the pan-psychistic viewpoint to suppose that organs of pain would be undeveloped in these very lowly forms. The simplicity of neural structure in these orders makes it certain almost that much, present in higher forms as organs correlated to consciousness of various modes, would here be lacking. The worm and the starfish, simply because they are in a less degree, physiologically speaking, individuals than is a dog or a man, require fewer of those organs on which a continuance of individuality depends. But while this is so, perhaps, the sort of pain under discussion is not man's degree of pain, but rather that grade of painful consciousness proportionate to the needs of the animal in which it may or may not be experienced. The difference is not one of kind but one of degree, and a degree suitable to the biologic needs of the particular species may be present, commensurate not to the complexity of a nervous system even, but perhaps only to the necessity of the preservation of individuality—a necessity in some of the species experimented on obviously exceedingly small.

In view of the great similarity functionally between the neural structures of the higher animals and those of man, no one perhaps would seriously deny consciousness to, say, an elephant or an ape. To damaging stimulation these animals react much as does man, but it is a quite gratuitous presumption that the earthworm and the flounder would react to a destructive excitation in a manner even comparable to that in which these higher forms react. To suppose this would be to employ again only a sort of the objectionable anthropomorphism. Because the elephant or the cat with a remarkably elaborate system of innervated, muscled, and jointed limbs, reacts in a characteristic way to injury, there is no reason to expect the Nereis or the starfish to react similarly in any sense. The rabbit even, with essentially all the motor mechanism which man possesses, 'expresses' pain often times only by attempts to get away and by an increase in the breath-rate; indeed this dyspnœa is often the physiologic anæsthetizer's only sign that more ether is urgently demanded. It is not necessary then because the lowest forms of animals do not act as mammals act under injury to presume on that account an absence of that degree of unpleasant consciousness which corresponds to the higher animal's pain. One might *à priori*, from difference in structure and in function both, expect wholly different reactions to stimuli or even none at all. Qualitatively as well as quantitatively the reactions of any two genera may differ to any indefinite degree.

Again that relative deficiency of simplicity of neural organs, natural to the low orders, may be and presumably is correlated with a like deficiency in the duration of the sensations represented by these organs. The time of continuance of a sensation occasioned by a momentary stimulation is perhaps determined by the number and extent of something comparable to association-currents running either between different parts of the neural unit or between these units extended spatially, or both. The former of these conditions may be simpler in the lowest orders, and the latter wholly or at least partly lacking. 'Reverberation,' in a word is less, the simpler the nervous organ. Professor Norman expressly noted in most of his experimental reports a period of quiet on the animal subject's part, representing nervous shock. It is a pure presumption to conclude that such a condition is not 'painful' to the animal. In all the higher animals severe pain is essentially asthenic in its effect on the organism. Limulus, cited by the writer, shows this especially well, and furthermore presents yet further evidence of painful or destructive sensation in the extreme abdominal flexion, the general concomitant of pain, noted in the experiments. This depressing period being past, and the perhaps only pseudo-individual being by the injury in no way incapacitated for its customary movements (because of lack of coördinating neural mechanism), these movements soon proceed as if nothing had happened, as indeed perhaps nothing had happened to more than an insignificant independent portion of the quondam individual.

Another consideration, quite old but on that account not less reasonable as it seems to the present writer, may be based on the biologic principle that nature does not act by leaps, that continuity is the all-pervading principle of evolution and so of psychophysical development. Man undoubtedly has consciousness and at times pain; the lowest organism has a minimum, but always some, of both, 'consciousness,' here indicating experience correlate with mechanical function, and 'pain' that sort of disadvantageous experience correlated with injury to the biologic egotism of the individual—very general terms, but therefore the more useful. Between these two zoologic extremes, the maximum and the minimum of developed life, all animal life has place and has accordingly, from this theoretical point of view, some degree or other of what, for want of a better term, is called pain. Each individual in its degree, be it man's degree or the earthworm's, has feeling, from this the philosophical view point, even as it has motion through space or within its organs. Let one who is disposed to deny this say with what genus sensation ends as one looks down the closely crowded scale of life—is it between man and the monkey or between the alligator and the flounder? However large the empirical gap at present between any two genera may be, the problem is not altered, for like biologic principles actuate them all, and strongest of these principles normally is the preservation of the individual. To this end, perhaps, pain developed, and to this end it everywhere, in the long run, works. This proposition is more than a mere speculative presumption, for observation inductively originated it and continually supports it. To get beneath it were to solve at length the great problem of Job, were to go deeper than empirical science can. It is a principle too firmly fixed in the philosophy of biology, so to say, to be shaken by the necessarily wholly negative result of experimentation where the conditions are so far from those of man, the judge.

George V. N. Dearborn.
Harvard University.

PLANT MATERIAL FOR LABORATORY USE IN THE SCHOOLS.

For more than a year there has been offered through the Ithaca Botanical Supply Co. plant material suitable for laboratory use in first courses, and for demonstrations of some of the organs and processes which it is rather difficult for beginning students to prepare. This work was undertaken at my suggestion by some students who were in need of financial assistance in their laudable endeavor to obtain a college education. It was undertaken both for the purpose of affording some aid in this way, and also for the purpose of assisting teachers and schools, especially secondary and normal schools, in the supply of material which is often difficult to obtain.

It should perhaps be stated that neither I, nor the botanical department here, has any official connection with, nor financial interest in, the scheme. At the same time I have taken a lively interest in the work in order to be assured that the material and the preparations should be of the first order. The persons who make the preparations are thoroughly familiar with modern methods and have attained a high degree of skill in preparing them. The permanent slides showing sexual organs and sexual processes in plants of the different groups are excellent and very beautiful. I am quite sure that those who are familiar with good technique will be quite surprised at the high degree of excellence presented in these slides, and certainly they represent the structures in a strikingly accurate manner. They put up in addition to other material, a 'high school set.' Persons or schools desiring further information can obtain a price list by addressing 'The Ithaca Botanical Supply Co.,' Ithaca, N. Y.

GEO. F. ATKINSON.

DO FISHES REMEMBER?

A RECENT paper* by Professor L. Edinger, entitled 'Haben die Fische ein Gedächtniss,' is primarily a statement of the conclusions which its author has reached as a result of his questionaire, 'Do Fishes Remember?' sent out in 1897. These conclusions are prefaced by some discussion of comparative psychology in general and some account of the sense-powers of fishes. The former is judicious but not new; the latter is convenient though not complete. Dr. Edinger is inclined to accept the decision that fishes do not hear sounds, though he seems not to know of the experiments of Dr. F. S. Lee, experiments more conclusive than any he reports.

Dr. Edinger's question as to memory is not about the existence of certain feelings of a thing as having been experienced before, but about the possibility of permanent associations, of after-effects of experiences. He asks concerning the fish nervous system, "Is this apparatus capable of in any way preserving impressions made upon it; do there exist after-effects due to previous experiences?" p. 16. Or, in other words, "Can impressions which are new to the animal, gain an influence on its activities; especially can they preserve this influence for a considerable time?" p. 17. He decides in a rather half-hearted way that they can, on the basis of the evidence obtained from the answers to his questionaire and elsewhere. He summarizes this evidence as follows: "(1) The inborn impulse to flee can be lessened by the animal becoming accustomed to impressions which formerly frightened it, but this tameness is lost if new stimuli enter into the experience. The impulse to flee can also appear in the presence of stimuli which have never been present before. Animals become afraid. By habit the sight of the one who feeds them may take the place of the optical or chemical stimulus which ordinarily leads to the act of feeding" p. 28.

Dr. Edinger's limitation of fishes' powers of forming associations and being influenced by them more or less permanently, to the single cases of tameness, fear and associations between the feeder and feeding, is misleading. It is no characteristic of fishes' mentality to form such habits rather than others. The prominence of such in the answers to the questionaire is due, not to the mental constitution of the fish, but to the interests of the observers. As a matter of fact the questionaire proceeding seems a very awkward way of answering the question about the permanent effects of novel experiences. One can, as has been shown in the December number of the *American Naturalist*, get direct evidence of the fact and demonstrate it to a class in the space of five hours.

Although familiarity with animal psychology proper and a bit more ingenuity might have

*Reprinted from *Allgemeinen Zeitung*, München, 21 und 23 October, 1899.

made Dr. Edinger's work more effective and his presentation much briefer, one cannot help feeling great satisfaction at seeing an eminent neurologist realize the value of comparative study by psychological as well as morphological methods. One must also admire the caution and thoroughness with which Dr. Edinger examines animal behavior. Above all one rejoices to see a piece of work in comparative psychology which presents facts without quarreling over the meanings of words.

Edward Thorndike.
Teachers College,
Columbia University.

THE GERMAN CONSULAR SERVICE.

Mr. Richard Guenther, Consul General of the United States of Frankfurt, writes to the Department of State that the 'seniors' of the Merchants Association of Berlin have addressed a memorial to the Prussian Secretary of Commerce, and at the same time to the Chancellor of the German Empire, which appears to be in response to an inquiry from the Secretary of Commerce, and states what reforms in the German consular service are deemed necessary. The following is a synopsis of the somewhat lengthy document: The main duty of the consul should be to make careful and detailed reports concerning economic occurrences in his consular district. These reports should give not only the figures of the exports and imports, but should also deal with the development of the commerce and the home industries of the country. The consul should be able to point out these conditions upon his own initiative, as well as in response to inquiries from home. He should be well informed about commercial matters at home, as well as in touch with the business world of his district. Means should be at his disposal for travel and he should be compensated for services rendered. Knowledge of the language of the country, as well as of the leading languages of the world, should be of prime consideration. The promotion system of Great Britain should be followed, whereby consuls are transferred between countries where the same languages and similar economic conditions prevail, so that transfers of a consul from China to Russia and thence to Spanish America, for example, should be avoided. Reports concerning the commerce of the foreign country should give comparisons with previous years and be published at home in such a manner as to reach all interested. The letter says that these requirements are more or less realized in foreign countries. The consuls of the United States of America especially have rendered very useful services to the commerce and industries of their home country and have furnished proof that the establishment of commercial consulates bears rich fruit, in spite of the fact that a consul can hardly acquire such special knowledge of trade conditions in the several branches as an agent of some business house. The letter endeavors mainly to show the great desirability of substituting the large number of German 'Wahlkonsuln'—*i. e.*, German merchants resident in some foreign country who act as consuls —by regularly paid consuls, who will give their whole time to their consular duties, and states that a reform is expected mainly from an increased and improved service in the regular consulates, recommending the appointment of commercial attachés to the important consulates, as has already been done at Chicago, Buenos Ayres and Constantinople. It is recommended that the qualifications for appointment as consuls should be of a more practical nature and not so much the mere knowledge of law. The letter also calls attention to the great usefulness of the Philadelphia Commercial Museum.

EDUCATION IN THE UNITED STATES.

The United States educational exhibit at the Paris Exposition will include a two-volume work entitled 'Education in the United States,' which has been planned and edited by Professor Nicholas Murray Butler of Columbia University.

The work consists of nineteen monographs, which, taken together, give a complete view of the present educational activity of the United States. It is proposed to present copies of the work to the leading governments, public libraries and educational institutions of the world, and the public will be given opportunity to purchase copies at a moderate price.

The several monographs which constitute the work, and their authors, are as follows:

1. Educational Organization and Administration—Andrew Sloan Draper, president of the University of Illinois, Champaign, Ill.

2. Kindergarten Education—Susan E. Blow, Cazenovia, New York.

3. Elementary Education—William T. Harris, United States commissioner of education, Washington, D. C.

4. Secondary Education—Elmer Ellsworth Brown, professor of education in the University of California, Berkeley, Calif.

5. The American College—Andrew Flemming West, professor of Latin in Princeton University, Princeton, N. J.

6. The American University—Edward Delavan Perry, Jay professor of Greek in Columbia University, New York.

7. Education of Women—M. Carey Thomas, president of Bryn Mawr College, Bryn Mawr, Pa.

8. Training of Teachers—B. A. Hinsdale, professor of the science and art of teaching in the University of Michigan, Ann Arbor, Mich.

9. School Architecture and Hygiene—Gilbert B. Morrison, principal of the manual training High School, Kansas City, Mo.

10. Professional Education—James Russell Parsons, director of the college and high school department, University of the State of New York, Albany, N. Y.

11. Scientific, Technical and Engineering Education—T. C. Mendenhall, president of the Technological Institute, Worcester, Mass.

12. Agricultural Education—Charles W. Dabney, president of the University of Tennessee, Knoxville, Tenn.

13. Commercial Education—Edmund J. James, professor of public administration in the University of Chicago, Chicago, Ill.

14. Art and Industrial Education—Isaac Edwards Clarke, bureau of education, Washington, D. C.

15. Education of Defectives—Edward Ellis Allen, principal of the Pennsylvania Institution for the Instruction of the Blind, Overbrook, Pa.

16. Summer Schools and University Extension—Herbert B. Adams, professor of American and institutional history in the Johns Hopkins University, Baltimore, Md.

17. Scientific Societies and Associations—James McKeen Cattell, professor of psychology in Columbia University, New York.

18. Education of the Negro—Booker T. Washington, principal of the Tuskegee Institute, Tuskegee, Alabama.

19. Education of the Indian—William N. Hailman, superintendent of schools, Dayton, Ohio.

EDUCATION ADMINISTRATION IN THE STATE OF NEW YORK.

IN his annual message to the Legislature, Governor Roosevelt refers to the proposed reorganization of the State of New York and the Department of Instruction as follows:

The University of the State of New York, with its Board of Regents, is an institution peculiar to this Commonwealth, and one now venerable with its 116 years of history. Its exercise of authority over higher education has been of very great public service, and its methods and standards have exercised a wide influence for good upon those of other States. These facts have led to the adoption, by the people, of an amendment to the constitution of the State, whereby the University itself and its organization under a Board of not less than nine regents, has been provided and safeguarded in the organic law.

The Department of Public Instruction, on the other hand, concerned chiefly with the supervision of all the free common schools of the State, supported by public taxation, has grown to a vast importance; for the number of children of school age in the State has largely increased, and nine-tenths of them attend no other institution than the public school. The work done in both departments has been, in the main, excellent and needful to be done; they are amply worthy of the confidence and continued support of the people. But that their work could be done better, if the two systems were unified, is a proposition hardly open to question. The problem has been not whether unification were desirable, but by what means this end was to be attained.

From the point of view of the public interests, it is neither desirable nor practical merely to extend the jurisdiction of either department over the other. The University convocation, at its annual meeting in July, 1899, requested the Governor to appoint a commission for the purpose of recommending a practical plan of unification, and in accordance with this suggestion the following commission were appointed:

Frederick T. Hollis, Daniel H. McMillan, Judge Joseph Daly, William Kernan, Robert F. Wilkinson, and the Secretary of the Board of Regents, and the Assistant Superintendent of Public Instruction. All were men of the highest standing, of trained capacity, and specially interested in the whole subject. I cannot too heartily thank them for their invaluable and wholly disinterested labor for the public welfare.

This commission, after careful consideration, has arrived at suggestions embodied in a report suggesting statutory changes which, if adopted by the Legislature, will give effect to the system which they recommend. What they propose is the creation of a Department of Education, including both the University and the Department of Public Instruction, of which a single officer, known as the Chancellor of the University, shall be the responsible executive and administrative head. The University is, of course, continued, and has its oversight extended to cover the entire field of education, so that its real authority and opportunity for public service will be much increased.

The plan proposed is simple, effective, and wholly free from political or partisan considerations. It deserves the cordial support of all friends of public education, and this means of every patriotic citizen of the State.

It is impossible to exaggerate the importance of the interests involved, or the importance of considering them solely from the point of view of the general welfare of the State.

INDIAN UNIVERSITY FOR RESEARCH.

Consul Fee writes from Bombay under the date of November 1, 1899, to the Department of State as follows:

The conference which has been sitting at Simla, the hot-weather capital of India, considering the scheme for a research institute, has about completed its labor. Its recommendations will be submitted to the government of India for sanction, and later will be put into legal being by proper legislation.

The inception of the idea of this institution is Mr. Tata's, a wealthy resident of Bombay, whose public spirit and munificence has made its creation possible.

It is to be named the 'Indian University of Research.' It will be unlike all other universities of India, in that it will neither be an examining body nor bestow degrees, but will grant fellowship to distinguished students and graduates, and afford them facilities for research and investigation in the broadest sense possible. It will have a university court, consisting of a chancellor, a vice-chancellor, one member to represent the supreme government of India, one to represent each of the eight local governments, one for each of the five existing Indian universities, one to represent Mr. Tata, and one to be added for any benefactor who may subscribe not less than 15,000 rupees.

The site, the question of which gave rise to no little discussion, was finally granted to Bombay, with Bangalore, the chief city of the native state of Mysore, as a second choice. The fact that the Mysore government had offered to donate a site and a handsome contribution to the building may have been an attraction.

It is recommended that this new university coöperate with existing institutions by giving assistance to original scientific research where this work is now in any way hampered or curtailed.

The conception of this institution is as broad as its ultimate development will be vast. It will give a livelier tone to higher education in India, and be a noble monument to its founders and promoters.

SCIENTIFIC NOTES AND NEWS.

Mr. J. B. Hatcher has been appointed chief of the department of vertebrate paleontology of the Carnegie Museum, in place of Dr. Wortman, who has resigned. Dr. Wortman will undertake work on the collections made by the late Professor Marsh for the Peabody Museum, Yale University.

Sir Robert Ball, F.R.S., was elected president of the Mathematical Association for the ensuing year at the annual meeting of the Association at University College, London, on January 27th.

The Prince Regent of Bavaria has conferred the order of St. Michael on Dr. Nansen.

The address at the commencement exercises of the University of Michigan next June will be delivered by John M. Coulter, Ph.D., head professor of botany in the University of Chicago.

DR. GEORGE F. BECKER, of the Geological Survey, who was recently sent by the government to the Philippines to report on the geology and mineral resources of the islands, has returned to Washington.

THE death is announced in Berlin of Dr. W. Hauchecorne, director of the School of Mines.

WE also note with regret the death, on January 13th, of Dr. J. W. Gunnings, professor of chemistry at Amsterdam, at the age of 72 years; of Dr. Peter Waage, professor of chemistry at Christiana, at the age of 57 years, and of General Alexis de Tillo, of St. Petersburg, known for his work in geography and meteorology.

THE mineralogical museum of Columbia University will be named after the late Thomas Eggleston, long professor of mineralogy and metallurgy at the University, to whose gifts and efforts the museum is chiefly due.

PROFESSOR G. H. PARKER, on January 29th, lectured before the New York Academy of Sciences, under the auspices of the Section of Biology. The title of the lecture was 'The Neurone Theory in the Light of recent Discoveries.' The lecturer gave a summary of the development of our knowledge of the histological structure of the nervous system, and contrasted with the neurone theory as widely understood that of Apathy's, which declares the absolute continuity of the nervous system by means of the fibrillæ in the nerve cells and fibers as demonstrated by his method of technique. The lecture was closed by a criticism of Apathy's interpretation of his preparations.

DR. EDWARD THORNDIKE, of Columbia University, gave a series of five lectures before the course in General Biology at the University of Chicago, February 4th to 9th. One of these was also open to all members of the University.

PROFESSOR T. H. MORGAN, of Bryn Mawr College, will repeat the course of lectures given at Columbia University at the University of Chicago, February 19th to 23d.

ON February 8th, Professor H. H. Turner, F.R.S., Savilian professor of astronomy in the University of Oxford, gave the first of a course of three lectures at the Royal Institution on 'Modern Astronomy.' On March 22d, Mr. H. J. Mackinder will deliver the first of a course of three lectures on 'Equatorial East Africa and Mount Kenya,' in the place of Mr. E. A. Fitzgerald, who is unable to deliver his course of lectures owing to his departure for South Africa.

LARGELY through the generosity of Mr. W. F. E. Gurley, formerly State Geologist of Illinois, the University of Chicago has come into the possession of an exceptionally valuable collection of paleozoic fossils. The making of this collection has been the life work of Mr. Gurley and it is undoubtedly the best existing collection of the paleozoic fossils of the interior States. It also contains a large amount of excellent material from other regions. The collection is estimated to contain 15,000 species, and several hundred thousand specimens. With this collection as a nucleus, the University of Chicago will be in position to build up one of the most valuable collections of paleozoic fossils in America.

MR. MORRIS STEINERT has given to Yale University his collection of historical musical instruments. It includes more than 500 pieces, including some of great value, representing the development of the piano and violin. The collection also includes musical manuscripts and original musical compositions.

BY the will of Mme. Beaucourt the Geological Society of France receives 40,000 fr., the income of which is to be used for research work.

IT is stated in the *Scientific American* that the sum of $7,550 has been given by Professors Haeckel, Conrad and Fraas, to be awarded for the best essays submitted on the application of the Darwinian theory to international political development and legislation. The essays must all be submitted prior to December, 1902.

THE American Section of the International Association for Testing Materials, of which Professor Mansfield Merriman, of Lehigh University, is chairman, has received contributions to its publication and research fund amounting to $655.

WE learn from the *National Geographic Magazine* that the French government will erect a meteorological observatory on a hill near Tonkin.

THE Weather Bureau proposes to extend its service by establishing stations at all the Mexican Gulf ports between Tampico and Progreso.

A TELEGRAM has been received at the Harvard College Observatory from Professor Kreutz, at Kiel Observatory, stating that Comet *a* 1900 (Giacobini), was observed by Javelle at Nice, February $3^d.2893$, Greenwich Mean Time, in R. A. 2° 49′51.″0, and Dec. —6° 40′ 10″:

Daily motion in R. A. — 39′
" " " Dec. + 25″

A CABLEGRAM to the daily papers reports that there were 400 deaths at Bombay on February 5th, more than on any day since the first outbreak of the plague.

THE congregation of the University of Chicago, at its meeting on January 3d, adopted a resolution to the effect that the official publications and journals of the University should use the simplified spelling recommended by the National Educational Association. This action was, however, overruled by a vote of 20 to 16 by the Faculty Senate.

ACCORDING to the daily press, the cable sounding ship *Nero* which arrived at Honolulu on January 29th, while between Guam and Manila, made the deepest ocean soundings that have yet been recorded. She found a large area over which the soundings showed 5260 fathoms, about 260 fathoms more than had ever been found before. This area was named Nero's Hole.

THE second annual meeting of the New England Association of Chemistry Teachers was held at the United States Hotel, Boston, on February 3d. Mr. Charles A. Pitkin, of South Braintree, reported for the committee on physiological chemistry, and Mr. Irving O. Palmer, of Newton, for the committee on new apparatus and methods, while Professor Theodore W. Richards, of Harvard University, told of Harvard requirements for admission in chemistry. Mr. Rufus P. Williams, of Boston, was elected president, and Mr. H. J. Chase, of Newton, secretary, for the coming year.

THE *Electrical World* states that the English army surgeons' employment of the Röntgen rays in field surgery has proved most successful, and has met with the highest commendation. Orders have been received for a fresh equipment and skilled operators, and before February it is likely that every column at the front will be furnished with a Röntgen ray outfit. Wireless telegraphy is also rapidly gaining ground. Marconi outfits are being installed on three British vessels destined for active service, as well as on the passenger steamers in the English Channel.

AT a New York State Civil Service Examination to be held on February 24th, the position of assistant in geology in the State Museum, will be filled. The salary of this office is $900. It is desired that candidates shall be graduates in civil or mining engineering.

A VACANCY exists among the second-class assistantships in the Geological Department of the British Museum, owing to the removal of Professor Gregory to Melbourne. Admission to these posts is by Civil Service examination in general and special subjects, after nomination by the trustees. The maximum limit of age has recently been lowered to 25 years. The British Treasury Department has, however, the power of appointing persons over this age and without examination, should a strong recommendation to that effect be made by the trustees. It is said, however, that such appointments have always been highly unpopular with the working staff.

ACCORDING to the bill now before Congress, providing for a Department of Commerce with a Cabinet officer, the Patent Office is removed from the Interior Department and placed under the proposed Department of Commerce.

A BILL has been introduced into the New York Legislature appropriating $200,000 for the construction and equipment of suitable buildings for carrying on the work of promoting knowledge throughout the State in forestry and agricultural lines by Cornell University.

THE president of the British Board of Agriculture has appointed a departmental committee to inquire and report as to what regulations may with advantage be made by the

Board of Agriculture, for determining what deficiency in the normal constituents of genuine milk or cream, or what addition of extraneous matter or proportion of water, in any sample of milk (including condensed milk), or cream shall raise a presumption that the milk or cream is not genuine. The committee will consist of the following gentlemen: Lord Wenlock, (chairman), Mr. George Barham, Mr. George Cowan, Major Patrick George Craigie (an assistant secretary of the Board of Agriculture), Mr. S. W. Farmer, Mr. Shirley F. Murphy, M.D., Professor Thorpe, F.R S. (principal chemist of the Government Laboratories), and Mr. J. Agustus Voelcker, Ph.D. Mr. Robert Henry Rew, of the Board of Agriculture, will act as secretary to the committee.

AN effort is being made by the New York Fish, Game and Forest League in New York State to secure the establishment of a State Biological Station. Professor H. A. Surface, chairman of the biological committee, writes that its purpose would be the making of investigations and practical experiments (*a*) to determine the nature, habits, food, and needs of the fish, game and insectivorous and song birds; (*b*) to determine the causes of their decrease; (*c*) to determine what measures can be taken to reduce their enemies, increase their natural food supply and shelter, and secure such natural or modified conditions as should lead to their abundance throughout the State; (*d*) to propagate not only the desirable creatures named above, but also their natural food supply; (*e*) to study and experiment with the best methods of introducing beneficial species, to show what measures can be taken to help them to become acclimated, and to provide for their winter feeding and shelter; (*f*) to obtain material for publication; (*g*) to obtain facts upon which proper legislation can be based to secure the effective protection and maintenance of desirable species and the destruction of obnoxious kinds; (*h*) to obtain facts that may be useful to teachers of nature study, natural history, biology, botany, zoology, ornithology, ichthyology or forestry in the State. Another important feature will be the preparation and labeling of collections of specimens (especially fishes and other aquatic and semi-aquatic animals) for schools of the State, which will stimulate scientific research and facilitate better methods of science teaching.

A MARINE laboratory and museum will be opened at the University of Berlin on the first of April.

A SECOND edition of the Botanists Directory, published by I. Dörfler, Vienna, is in preparation. The publisher will be glad to receive the names and addresses of all botanists, especially those whose names do not appear in the first edition, as well as information concerning botanical gardens and societies concerned with botany.

WE learn from the *London Times* that the report by Sir William Crookes, F.R.S., and Professor Dewar, F.R.S., on the composition and quality of daily samples of the water supplied to London for the month ending December 31, 1899, states that of the 192 samples examined by them during the month, all were found to be clear, bright, and well filtered. The rainfall at Oxford during the month was 1.30 in. The average for the past 30 years is 2.10 in.; this leaves a deficiency of 0.80 in., bringing the total deficiency for the year up to 4.54 in., or 17.6 per cent. The general supply has been admirable from a bacteriological point of view. During the year they examined 4792 samples of London water bacteriologically, as compared with 3590 and 3249 respectively in the two previous years. They also made 2456 chemical analyses of London waters, making a total of 7248 samples examined. During the first six months the Thames-derived companies clear-water wells contained on the average 32 bacteria per cc., while the New River and River Lea supplies contained respectively 18 and 25. During the second six months the number of bacteria in the waters from the three were respectively 22, 12, and 14. These results show that during the year effective filtration of the London waters has been properly maintained. The report adds: "When we consider that a water containing about 100 bacteria per cc. in the clear-water wells would be regarded by the highest authorities as properly filtered, we see that the London supply must be considered exceptionally good."

THE *British Medical Journal* states that there are now eight Pasteur Institutes in France; arranged according to the dates of their establishment, they are those of Paris, Algiers, Tunis, Montpellier, Marseilles, Bordeaux, Lille, Lyons. The last was opened on the first day of this year. There are five like institutes in Italy (Bologna, Milan, Naples, Palermo, Turin), two in Austria-Hungary (Vienna and Buda-Pesth), seven in Russia (St. Petersburg, Moscow, Samara, Kharkof, Warsaw, Odessa, Tiflis), two in the Ottoman Empire (Constantinople, Aleppo), one in Roumania (Bucharest), and one in Malta.

'Variations and Regeneration in Synapta inhaerus' on page 178 of the number of Science for February 2, 1900, should have the name of the author, Professor Charles L. Edwards, attached to it.

UNIVERSITY AND EDUCATIONAL NEWS.

Plans for a botanical laboratory to cost over $100,000 have been submitted to the Senate of Cambridge University.

The new wing of the engineering laboratory at Cambridge University, erected in memory of the late Dr. John Hopkinson by his widow and family, was formally opened on February 2d by Lord Kelvin; and at the same time a portrait of Dr. Hopkinson was unveiled.

St. Lawrence University has recently received a gift of $24,000 from a friend of that institution.

The Massachusetts Institute of Technology offers a new course in landscape architecture which, as provisionally laid out, includes in the second year horticulture, elementary architectural design, shades and shadows, perspective, freehand drawing, surveying, topographical drawing and dynamical geology, with the usual general courses in physics, language and history. In the third year the same general lines of work will be followed, with work in horticulture at the Arnold Arboretum, architectural and landscape design, architectural history, freehand drawing and pen and ink, stadia and plane table surveying, curves and earth-work, highway engineering and structural geology. In the fourth year, landscape architecture and design and horticulture will be the main features, with courses in sanitary engineering and drainage, building stones and sanitary science, history of ornament, life class, modeling, pen and ink, water color, specifications and working drawings and business relations. An arrangement has been made with the director, Prof. C. S. Sargent, of the Arnold Arboretum, by which students will receive a part of their instruction there, particularly in all that relates to planting and the use of plants and trees. With this work at the Arboretum will be combined a series of excursions to neighboring parks and country places in order to study examples of planting and design. The special instruction in landscape design will be conducted by Mr. Guy Lowell a graduate in the class of 1894, who has since taken the diploma of the École des Beaux Arts with distinction, and has made a special study of landscape architecture in Europe.

The course of landscape architecture, at Harvard University, the establishment of which we recently announced, has been placed under the direction of Mr. Frederic Law Olmsted, Jr. He will be assisted by Mr. Arthur A. Shurtleff.

The Techincal Education Board of the London County Council offers two scholarships of £150 each to teachers in schools. They are tenable from Easter to Christmas 1900, and enable the holder to visit the continent and study methods of teaching modern languages in commercial schools.

The foundation of a chair of American Archæology at the University of Berlin by the Duke of Loubat, has given a great impetus to the development of the teaching of anthropology at that University. Recently it has been announced that Adolf Bastian has been made Professor Ordinarius of Ethnology. This has been followed by the announcement of the appointment of Dr. Felix von Luschan as Professor (extraordinarius) of Anthropology.

Nichols Knight, Ph.D., of Syracuse University, has been appointed professor of chemistry at Cornell College, Mt. Vernon, Ia.

June E. Downey, A.M. (Chicago), has been appointed instructor in psychology at the University of Wyoming.

SCIENCE

FRIDAY, FEBRUARY 23, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*ARE FURTHER EXPERIMENTS NEEDED FOR DETERMINING THE ATOMIC WEIGHT OF OXYGEN?**

THE precision of experiments on the atomic weight of oxygen has been gradually so much increased that, in some cases, the mean error of a single determination is less than 1 part in 10,000. The agreement of different series of experiments is not so good, but if the work of different experimenters agreed well, the question, how accurately do we really know the atomic weight of oxygen, is not one which we can readily answer. Neither the concordance of the experiments of a given series, nor the agreement of the results of series of experiments by different observers, can excuse us from search for sources of error. All sciences which have to do with measurement afford sufficient instances of the fact that our conclusions are to be received with a certain suspense of judgment. And chemistry well illustrates that he is wise whose assertions regard the possibility of finding at some time evidence to the contrary.

The history of experiment on the atomic weight of oxygen affords an interesting example of the fact that neither the concordance of individual observations nor the agreement of different experimenters proves that a measurement is right. To-

* President's address, delivered before the New Haven Meeting of the American Chemical Society.

ward the middle of the century, Dumas made his classic experiments on the composition of water. The probable error of a single experiment was, in round numbers, 1 part in 400, so that the probable error of the average of the 19 famous experiments was 1 part in 2250. Now, this means that his final value was not likely to differ more than a certain small quantity from the result of the repetition of even a very large number of experiments made in the same way, with the same skill and care. But as to the difference between this result of the 19 experiments and the unknown true value, we are told absolutely nothing by the proposition that the probable error of Dumas' result was 1 part in 2250. It is a commonplace to say, that the calculation of the probable error of a series of experiments does not show how nearly the result approaches the truth, but how near it is to the result of a greater number of similar experiments. It decides, not how nearly we approach the desired goal, but whether it is useful to persevere by the present method of approach. Dumas made 19 observations, and got the value, 15.96, with a probable error of 0.007; that is, if he had made 100 or 1000 experiments, it is unlikely that the final result would not have been between 15.95 and 15.97, and very unlikely indeed that it would not have been between 15.94 and 15.98. But he would never have obtained a value near that which now commands confidence.

It is interesting to recall that there is hardly any instance on record where the judgment of an experimenter as to the degree of approximation to the truth attained in his work has been better justified than in the case of Dumas' classic experiments. As we all remember, towards the end of his work, there was discovered in his own laboratory a source of error, not easy to eliminate, which had affected all his determinations. The amount of the error was not a fixed quantity, and no numerical correction could be applied to the results of observation. Dumas accordingly gave to the public the uncorrected and unmodified results of experiment. But he also stated his opinion as to the degree in which his results approximated, not to the mean of a larger number of experiments of the same kind, but to the unknown and unattainable true value. He expressed the hope that his value would be found not more than one part in 200 from the result of those subsequent experiments which should be thought satisfactory; and it is by just 1 part in 200 that his value differs from that which is now accepted.

So the concordance of Dumas' experiments did not prove that his result was right; neither did the agreement of experiments by different observers. Erdmann and Marchand made eight experiments by a method like that of Dumas, with some modifications. Their result was 15.973, with a probable error of 0.011. This value differs from that of Dumas by less than the sum of the probable errors, so that that agreement is perfectly satisfactory. So, also, Regnault determined the ratio of the densities of oxygen and hydrogen, from which was computed the atomic weight of oxygen as 15.963, with a probable error of 0.004. The results of Dumas, of Erdmann and Marchand, and of Regnault, show a very good agreement. But all of them, and the mean of all of them, we now know to be in error by 1 part in 200.

I adduce this example, somewhat in detail, to enforce the proposition that we must not excuse ourselves from looking for error because observations agree. We have experiments which give the atomic weight of oxygen with a probable error of 1 part in 50,000, but do we know it within 1 part in 1000? Each individual experimenter whose work would now be regarded as free from known and tangible error, agrees fairly well with the mean of all. For instance, Noyes' results show that degree of concordance which would justify us in expecting that, if he were to make 100 or 1000 experiments, his final mean would be as likely as not to be larger or smaller by 1 part in 9500, and his result differs from that which we accept by 1 part in 900. So Cooke and Richards assign a value which is just as likely as not to be within 1 part in 8000 of the result which they would have obtained by multiplying observations; and it differs from that which we accept by 1 part in 1500. But do we know that their means, and the means of all published results taken together, are not in error by 1 part in 900? The concordance of the results of a single experimenter, and the agreement of different experiments, does not justify us in asserting that we do.

In determining the atomic weight of oxygen, it has been somewhat difficult to determine directly all three of the quantities involved, and so to make what Stas called a *complete* synthesis. Berzelius, Dumas, and Erdmann and Marchand, weighed oxygen and weighed water, thus determining hydrogen by difference. More recently, Dittmar and Henderson and Leduc used the same method. Cooke and Richards, and Keiser weighed hydrogen and weighed water, while Rayleigh and Noyes weighed hydrogen and weighed oxygen. Any proceeding which weighs hydrogen directly has a great advantage in precision; different determinations in a given series agree better among themselves, and the series of different experimenters also agree better. But there is also a second, more important advantage. We have reason to believe that the constant errors involved in weighing hydrogen are small, for it is possible to obtain hydrogen with less than $\frac{1}{10000}$ or even $\frac{1}{20000}$ of its weight of impurity. There is no difficulty in weighing oxygen or water with accuracy, so if we weigh hydrogen and also weigh either oxygen or water, we may hope for a near approximation to the true value of the ratio sought.

We may hope, but we cannot *know*. We may believe that our hydrogen is pure, and that there was no error through leakage. But an unsafe stop-cock might make the apparent weight of the hydrogen in a series of experiments seem always smaller than the fact, and might yet leave the individual experiments so concordant with each other as to seem trustworthy.

If, however, we can weigh hydrogen and can weigh oxygen, and then combine them and weigh the water produced, we can at least give a better reason for our hope, if we find that the product is nearly equal to the sum of the components. The manipulation in this case is costly, and is so difficult, and involves so many minute details, that not many have patience and time sufficient for it, so that no great number of such complete syntheses has been made, and these few were made in conditions but little varied. When such complete syntheses shall have been made by different observers, with those variations of apparatus and method which may seem wise to them, we shall be able to judge of the magnitude of the errors to be feared. If such results are not concordant, we shall have much to learn as to sources of error; but we now see some reason to expect that they will not be discordant. However, even if they are not discordant, we are not to excuse ourselves from further study of sources of error.

Before repeating determinations so troublesome, and before studying unknown sources of errors not yet detected, the experimenter should receive all possible assistance from chemical theory and from criticism. For some, that criticism may be most profitable which is friendly and sympathetic; but, for the experimenter, the value of the criticism depends on the knowledge and the acuteness of the critic. Dr. Hinrichs published, some five years ago, a criticism of all determinations and computations of atomic weights since Dumas. As is well known, he is a most strenuous and insistent supporter of Prout's hypothesis. Looking hastily through the volume, there was found, towards the end, evidence that its author was one of those who, some thirty years ago, discerned that which, in the hands of Mendeléeff became the periodic law. It seemed possible that one who had early seen some indications of this law might, perhaps, also have discerned, even if obscurely, some principle relating to atomic weights. I therefore once spent some time and pains in carefully reading the book, and considered at length those passages, which, if any, contained valid criticism of the views which are generally accepted.

Hinrichs believes that the mean of a series of determinations of an atomic weight cannot give the true value sought. This proposition he deduces from a mathematical discussion. He believes that as larger and larger quantities are taken in our analytical operations, the results differ regularly from ideal accuracy; sometimes the difference continually increases as the quantity taken increases; sometimes the difference increases to a maximum and then decreases again. The proper computation of an atomic weight then, according to Hinrichs, consists not in taking the mean of different observations, made with different weight of materials, but in determining the limit towards which the series converges as the weight taken decreases. A good illustration is given: we cannot determine the weight of a new coin by weighing any number of old coins; every coin is worn and therefore light, and the mean weight of any number whatever is therefore necessarily below the mean weight of new coins. But if we weigh old coins and note the date of each, we may take the mean weights for each year separately. If we examine coins enough, these means when plotted as the ordinates with the years as the abscissas, will give us a "fairly regular curve, lowest for the oldest coins, gradually rising towards a *limit* which they would not quite reach. This higher limit would evidently be the mean weight of the new coin."

This is an intelligible proposition. It seemed to me worth while to examine it, for to this proposition one of the most enthusiastic and most active supporters of Prout's hypothesis, a man not lacking in shrewdness or ability or learning, has entrusted the defense of his favorite belief.

He asserts that an atomic weight as determined by experiment is variable, that it depends on the amount of substance taken for the analysis or other operation, and that it varies in a continuous and regular manner. His proposition is, that an atomic weight as determined by experiment is a function of the weight of substance taken. Is there any evidence in favor of it?

I answer, first: Theory does not afford any evidence for it. Hinrichs deduces this proposition from theory by a discussion which is mathematical in form. Whether the proof is sound need not be considered, for his theory does not attempt to show the order of magnitude of the regular and continuous variations which are affirmed to depend on the weight of substance taken, and to show whether they can be separated from the irregular and discontinuous errors due to accident. We are sure that accidental errors exist; we may concede for argument, that regular and continuous variations also exist; but this is far from implying that the actual errors in a given set of experiments will be largely or even perceptibly of the latter kind. Theory shows that there is a diurnal tide in the atmosphere; but theory does not show that the differences noted in a series of ten observations of the barometer at different hours of the day will follow the law of the diurnal tide.

But, secondly: Facts do not agree with the proposition. The accidental errors of the most precise experiments yet made are so much greater than any *systematic* variations, that nothing but accidental variations can be detected. To prove this, let us consider Stas' synthesis of silver nitrate from pure silver. This is one of the most important determinations ever made; Hinrichs has discussed it twice in his volume; he asserts that the ratio of silver nitrate to silver found in each analysis depends on the weight of silver taken, and twice draws curves to show this. I assert, on the contrary, that the errors, which average only 1 part in 40,000, are purely accidental, and that they follow no law. This can be proved by proving that the ratios obtained depend on any other quantities selected by accident just as much as they depend on the weights of silver taken. Hinrichs plots the results of the ten determinations, using for abscissas the weights of silver taken, and so obtains tolerable curves. I plotted the same ten observations, using for abscissas not the weights of silver taken but ten numbers selected by *sortes Virgilianæ*, and get curves quite as tolerable as before; and this I did with ten different sets of abscissas, all selected by pure accident. Now, quantities which depend on any one of eleven sets of abscissas, ten of which are selected by accident, are themselves accidental in their variations, and the variations follow no law. So far as the facts are examined, they give no evidence in favor of Hinrichs' proposition; we have seen that theory is equally chary of her support, and we may safely dismiss the suspicion that any source of systematic error can be detected in deducing atomic weights from the means of good experiments.

Within the limits of convenience, it is well to vary the amount of substance taken in analytical determinations. This has been a frequent practice in the finest investigations. But that this practice derives any support from the so-called 'limit method' cannot be conceded.

This criticism, this attempt at a theory, then, removes no obstacles and reveals no threatening pitfalls. If we desire a firmer foundation for our system of atomic weights we must simply enlarge the experimental basis of our knowledge.

If it is only by further experiment that we can make surer of the atomic weight of oxygen, we are to consider what kind of experiments is most desirable. It is chiefly for the sake of eliciting discussion on this point that the subject of this address has been chosen.

Our present value for the ratio between oxygen and hydrogen rests on one single chemical combination, and upon two processes for determination. The first is, the synthesis of water from its components. The second is, the determination of the densities of the gases and of their volumetric ratio. Let us consider these in order.

What synthetic experiments should be repeated? We are met by the fact that a complete synthesis, in which hydrogen and oxygen and water are all three weighed, can be made with errors only about one-fourth as large as the errors in any of the syntheses where only two substances are weighed out of the three concerned. Other things being equal, then, this process is by far the most promising. But, so far it has been carried out adequately by only one experimenter. Conditions were varied somewhat, it is true, but by no means so much as they would be varied if the same person repeated the experiments after an interval of years; by no means so much as if others were to undertake such complete syntheses. Lately, Keiser has devised a process which varies in many particulars from that already executed; it is very desirable that he should make a series of experiments, after adequate study of sources of error and of means of avoiding them. It is also desirable that, if possible, the original process of complete synthesis should be repeated with the little modifications which time is sure to introduce. These two would be enough, as far as synthesis is concerned; unless, indeed, through the invention of another process by a third experimenter, we could have still more. Other syntheses of water than by a *complete* synthesis seem less likely to be of much service, except as a school of experimentation.

What further work is desirable on the ratio of densities and of combining volumes of hydrogen and oxygen? Three constants are involved: the density of oxygen, the density of hydrogen, and the volumetric ratio.

The density of oxygen is known with a probable error of about 1 part in 50,000. It is very probable that no number whatever of further determinations would change this value by 1 part in 10,000. No further work upon this density seems at present desirable, except that whoever determines the density of hydrogen cannot well fail to determine that of oxygen also.

The density of hydrogen demands further experiment. It is possible to make, by some one of three or four slightly different processes, a series of experiments whose average variation shall be less than 1 part in 3000 or 5000, or even 10,000; but different series do not agree sufficiently with each other. We are far from knowing the density of hydrogen so well that more observations might not change our value by 1 part in 2000 or 3000. It is very desirable that further observations should be undertaken by at least two different methods. In one method, hydrogen should be weighed while absorbed in palladium, should be then transferred to a measuring apparatus without the use of stop-cocks, and should be there measured. This process should be repeated with measuring apparatus of varied volumes. In another method, hydrogen should be weighed after Regnault's method, in a counterpoised globe, but with such precautions that leakage through a stop-cock, and contamination with vapor of mercury, should be excluded. The globe should be exhausted till the remaining air is a small fraction of a millionth, should be sealed off from the pump, and should be connected with a condenser at the temperature of liquid air, so as to remove mercurial vapor. After this hydrogen is to be admitted without the use of stop-cocks. The manipulation is not difficult, and the method would confirm the results of the previous method.

The ratio of the combining volumes of hydrogen and oxygen is not known with the degree of confidence which is desirable. The history of the matter is not an uninteresting one. Further continuance of the two series of experiments on which the present value depends would be most unlikely to change it by 1 part in 10,000, for its probable error is 1 part in 40,000. But one of the experimenters has obtained results differing from that finally adopted by as much as 1 part in 220. The other experimenter has entirely discarded the result of one series and replaced it, not by a better series of the same kind but by one of a quite different nature, not carried to its proper completion, and accordingly reduced by the use of the constants of van der Waals' equation. It is desirable that experiments be made to furnish means for a new reduction by measuring the change of volume when 2 volumes of hydrogen and 1 volume of oxygen are mixed, being at the same pressure before and after mixing. This experiment has lately been made by Berthelot, whether with sufficient precision for the purpose is not known at this moment. It is also desirable that the ratio of the combining volumes of oxygen and hydrogen should be measured with the gases contained in vessels of the dimensions of those used for obtaining their densities.

If these syntheses and these studies of ratios of densities and combining volumes should agree as well as it is safe to expect, we should know the atomic weight of oxygen as confidently as we can know it while the value rests on a single chemical process, the combination of the two gases to form water.

But this is not so much as is desirable. We know the atomic ratio between silver and oxygen with considerable confidence, because this rests not on a single chemical process but on eight different chemical processes, which give eight independent results, and because these eight results agree. Is there, then, any chemical process by which the atomic ratio of oxygen and hydrogen can be determined, other than the analysis or synthesis of water? Is there any element whose atomic ratio to oxygen is well known, whose ratio to hydrogen is capable of accurate direct determination?

It is probable that, given an adequate equipment, the direct ratio of hydrogen to chlorine, of hydrogen to sodium, of hydrogen to magnesium, or of hydrogen to aluminum, could be determined with sufficient precision for the purpose, provided that the ratio of chlorine to oxygen, of sodium to oxygen, of magnesium to oxygen, and of aluminum to oxygen are well enough known. This may not now be the case with aluminum or magnesium, but is the case with chlorine and with sodium, whose atomic ratios to oxygen may be fairly assumed to be known within 1 part in 2500. If, now, we can determine the ratio of chlorine to hydrogen, or of sodium to hydrogen, to 1 part in 5000, we could compute, by a new method, the ratio between hydrogen and oxygen. If this should agree with the present value, within some such quantity as 1 part in 2000, we should be as confident of the truth of our value of the atomic weight of oxygen as we can well hope to be.

The difficulties in making a complete synthesis of hydrochloric acid are not small, nor are they all well understood. Some unexpected circumstance may be prohibitive. But there is good reason to hope that 3 or 4 or 5 grams of hydrogen could be weighed, that a nearly equivalent quantity of chlorine could also be weighed, that the two could be combined, and that the product could be weighed. One serious difficulty would be found in attempting to prepare pure chlorine, but the difficulty does not seem insuperable. The manipulation of the corrosive element requires invention, but seems not difficult. For the collection of the hydrochloric acid in a weighable form, there seem to be alternative methods, not very troublesome of execution, unless unforeseen difficulties are encountered. If the ratio between hydrogen and chlorine could be determined to 1 part in 5000 or to 1 part in 10,000, it would be a very interesting addition to our list of known constants, most helpful in establishing confidence in the ratio between oxygen and hydrogen.

So, also, if sodium can be prepared of sufficient purity, or of sufficiently constant impurity, it seems possible to weigh 100 or 200 grams, to act on with water in such a way as to produce a slow evolution of hydrogen, and to determine the weight of this hydrogen by loss. Whether sodium can be obtained sufficiently free from absorbed hydrogen and whether it can be prepared for weighing without attacking the vessels which contain it, are questions which need further experiment. It is probable that a vessel of platinum-iridium alloy could be made which would make success almost certain, but at considerable cost. In this case also, if the ratio between sodium and hydrogen can be determined to 1 part in 5000, or 1 part in 10,000, the result would inspire confidence, or, if it must be, distrust, in our present value for the ratio between oxygen and hydrogen.

These suggestions, necessarily tentative in their nature, are submitted to the American Chemical Society, in the hope of obtaining from those who do me the honor to listen to them or to read them, expressions as to the desirability of making experiment in the lines described, and discussions of the new methods indicated as possible.

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CRUISE OF THE ALBATROSS.
III.

Mr. Agassiz's third letter written from the *Albatross* to Hon. George M. Bowers, U. S. Commissioner of Fish and Fisheries, is dated Suva Harbor, Fiji Islands, December 11, 1899, and is as follows:

We left Papeete, November 15th, after coaling and refitting on our return from the Paumotus. During our trip to Suva we made a few soundings from Tahiti to Tonga, striking the northern extension of the deep basin lying to the eastward of Niue; the depths ranged from 2472 to 2882, the bottom being red clay. This would indicate a greater extension westward of the zone over which the manganese-nodule bottom extends.

After leaving Niue we steamed for the deep hole of the Tonga-Kermadec Deep, about 75 miles to the eastward of Tonga-Tabu, and in 4173 fathoms made a haul with the Blake beam-trawl, by far the deepest trawl haul yet made. The gear was carefully inspected and strengthened as far as practicable by Captain Moser, and it was with considerable anxiety that we laid out 5000 fathoms of wire rope for our haul. Fortunately, everything went off successfully and we landed the trawl safely back on deck. To my great surprise we found in the bag a number of large fragments of a silicious sponge belonging probably to the genus *Crateromorpha* which had been obtained by the *Challenger* in the Western Pacific, but in depths less than 500 fathoms. We also brought up quite a large sample of the bottom; it consisted of light-brown volcanic mud mixed with radiolarians.

We decided to trawl at 4173 fathoms rather than wait for a possibly deeper sounding, as the conditions for work were admirable and we did not care to run any risk from a change of weather. After our haul we made a still deeper sounding in the proximity of the 4762-fathom sounding marked on the chart, and found 4540 fathoms with the bottom of the same character as at the place where we trawled. We also took a couple of soundings in the line from Vavau to the southern extremity of the Lau Group in Fiji, but found, as we expected from the soundings given further south, comparatively shoal water, viz., 1381 fathoms. In the channel north of Yangasá, where we crossed the Lau Plateau between Yangasá and Mothe, we found 453 fathoms, with bottom composed of coral sand, pteropod ooze and a few globigerinæ. Between Namuka and Yangasá we obtained 324 fathoms, between Namuka and Marambo 600 fathoms, and between it and Kambara 450 fathoms, and finally about 15 miles west of Kambara we sounded in 990 fathoms. These soundings would indicate a continuous plateau of moderate depths from Wailangolala south upon which the islands of the Lau Group rise.

On our way back to Papeete from the Paumotus we examined the eastern coast of Tahiti, and from Papeete examined the western coast as far as Port Phaeton at Tararao Isthmus. We examined in a general way the Leeward Society Islands: Murea, Huaheine, Raiatea, Tahaa, Bora-Bora, Motu Iti and Maupiti. There are excellent charts of the Society Islands, so that it was comparatively simple to examine the typical points of the group and to gain an idea of their structure as far as it relates to coral reefs. The Society Islands are all volcanic islands edged with shore platforms, some of great width, upon which the barrier or fringing reefs of the islands have grown. The structure of the reefs of the Society Islands is very similar to that of the Fiji reefs round volcanic islands. A comparison, for instance, of the charts of Kandavu, Viti Levu, Mbengha, Nairai, and and of other volcanic islands in the Fijis, with those of the Society group, will at once show their identity. Huge platforms of submarine denudation and erosion characterize both, with fringing and barrier reefs determined by local conditions. Perhaps it is easier to follow the changes which have taken place in the Society Islands; and such islands as Tahaa and Bora-Bora, where we anchored, as well as Maupiti, are admirable examples and epitomes of the structure and mode of formation of the coral reefs of that group.

In Motu Iti and Tetuora the volcanic peaks have disappeared, leaving nothing but a shallow platform upon the outer edges of which sandy coral islets have been thrown up. There is, however, one point in which the barrier reefs of the Society Islands differ from those of Fiji. The barrier reefs in Fiji are generally indicated merely by reef flats, upon which the sea breaks, and an occasional rocky islet or negro-head; only rarely do we find sand keys upon the fringing reefs of the islands of Fiji. In the Society Islands, on the contrary, we find the line of the barrier reef usually well indicated by long lines of narrow islets thrown upon the reef platforms, exactly as they are in the Paumotus. These islands and islets are usually well wooded, and thus give a very peculiar aspect to the barrier reef. In the case of Bora-Bora, Maupiti and Aitutaki, for instance, we have a central volcanic peak of considerable height surrounded by a wide lagoon, the sea edge of which is formed by a fringe of wooded islets and islands forming a more than half-closed ring around the central island which, in Bora-Bora and Maupiti, rise in slopes and nearly vertical walls, the former to a height of nearly 2400 feet, the other about 1100 feet.

The only island of the Cook group which we examined was Aitutaki, as Atiu is composed of elevated limestone, and Rarotonga is volcanic. I hoped we might find that atoll to be in part volcanic and in part composed of elevated coralliferous limestone; we found it to be volcanic, an island with the structure of Bora-Bora on a smaller scale.

We anchored at Niue, an island composed of elevated coralliferous limestone showing three well-marked terraces, the lowest of not more than 5 to 10 feet and in many places disappearing completely, the limestone cliffs rising vertically from the sea well into the second or even the third terraces. The vertical faces of the cliffs are dotted with caverns and deeply indented by small cañons extended at right angles to the face of the shore or forming blunt headlands separating short reaches of coral sand beaches. The second terrace varies in height from 50 to 60 feet, the third from 90 to 100 feet. The second terrace is deeply undercut; and in the higher vertical cliffs extending into the third terrace from the sea, the former positions of the terraces are usually indicated by lines of caverns. There are corals on the sea slopes of the first terrace extending to 10 or 12 fathoms growing much as they are found at Makatea.

From Niue we went to the Tongas, which we found a most interesting group. The elevated tertiary coralliferous limestones take here their greatest development, and are on a scale far beyond that of their development in the Lau Group of the Fijis or the Paumotus. The first island of the Tongas we visited, Eua, is perhaps the most interesting of the islands composed of tertiary elevated coralliferous limestone I have visited. From Dana's account of it, evidently given at second hand, I expected to find an island somewhat like Viti Levu on a very much smaller scale. But as we steamed up to it from the east there could be no mistaking the magnificent face of nearly vertical limestone cliffs forming the whole eastern face of the island, and at points rising to over a thousand feet in height. At all projecting points lines of terraces were plainly marked; at the northern point three could be followed, and at the southern extremity five, with perhaps traces of a sixth.

Upon rounding the southern extremity of the island we could see that the island was composed of two ridges, running north, separated by a deep valley, the western ridge being much lower than the eastern, not rising to a greater height than a little over 500 feet. The western ridge is also composed of limestone, and at the headlands we could trace three terraces. There is a narrow shore-platform along the western face, at many points of which there are blow-holes where the sea throws up spray to a considerable height, but these blow-holes are best seen off Cook Point, the southern extremity of Tonga-Tabu.

As we steamed along the western face of Eua Island, we could see the ridges of the eastern side rising above the crests of the lower ridge, its slopes indicating a valley of considerable size. We anchored at English Roads, opposite the outlet of the drainage of the interior basin where a small river has cut its way through a depression in the shore terrace. On landing we followed the crest of the western ridge for a few miles and could see the whole valley forming the basin of the island lying between the two ridges, at our feet; the slopes leading to the bottom are quite gentle, and the valley dips very gradually northward back of the outlet, on the western shore. Nothing could show more clearly that such an island was not an elevated atoll, but a plateau which has been eroded and denuded for a long period of time by atmospheric and other agencies, and in which a deep basin-shaped valley with gentle slopes has been gouged out—a plateau similar to that of Tonga-Tabu Island and of Vavau, but of greater height and less extent.

To the westward of the Tonga Islands is a line of volcanic islands extending nearly 200 miles from Honga Hapai to Fanualai, some of which have been active very recently. Falcon Island disappeared in 1898 and Lette is still active. This line of volcanoes runs at a distance of from 15 to 20 miles parallel with the trend of the four irregularly shaped plateaus upon which rise the Tonga Islands. They are the summits of a great ridge over 200 miles in length, sloping very gradually to the westward and being somewhat more steep to the eastward, into deeper water, towards the smaller platforms from which rise the volcanic peaks of the group. The plateaus of Tonga-Tabu, Namuka, Hapai, and Vavau, being separated by deep valleys connecting the eastern and western flanks of the ridge. These four plateaus rise abruptly from the 100 fathom line. The extremity of the southern one is occupied by Tonga-Tabu Island. The land behind the cliffs of its southern coast rises to a height of over 250 feet and slopes northward very gradually to form the low land which occupies the north coast of the island, and is, except, at Mount Zion and Cook Hill, not more than from 10 to 20 feet above the level of the sea. At Cook Point (and along the southern coast) three terraces are indicated. The northern coast is deeply indented by shallow bays, full of islands, reef flats, and reef patches, on which corals grow in great profusion. In a distance of nearly 10 miles northward of Nuku-Alofa the plateau is nowhere more than 15 fathoms deep; and a long tongue runs northward, gradually deepening into 20 to 50 fathoms to the 100-fathom line.

The Tonga-Tabu plateau is separated from the Namuka Group Plateau by a funnel-shaped channel with a depth passing rapidly into 300 fathoms from the 100-fathom line. The Namuka Plateau is rectangular. The principal island is Namuka, where we anchored. We found the island to be composed of tertiary elevated coralliferous limestone with a shallow sink, filled with brackish water, occupying the southeastern part of the island. The sink is separated by a high sand beach, about 200 yards wide, from the sea.

Namuka Iki, the island next to Namuka, we found to consist, at its southern extremity, of stratified volcanic material resembling somewhat the so-called soapstone of Fiji. I was told that other islands in this group, near Tonumeia, in the center of the Namuka Plateau, were volcanic. Mango, as we could see it from our anchorage, appeared to be volcanic. So that this part of the Tongas is, like the Lau Group in Fiji, made up of islands in part volcanic and in part composed of elevated coralliferous limestone. The eastern edge of the Namuka Plateau (which we did not visit) is edged with small low islands. We merely steamed past the western islands of the Hapai Group, but close enough to see that Tongua, Kotu, and Fotuhaa, which are respectively 120, 120 and 200 feet high, are composed of elevated limestone. The eastern flank of the Hapai Plateau is edged with long low islands with extensive coral reefs along the reef flats of these islands.

The Hapai Plateau is triangular, with isolated islands rising on the northwestern side from the deep water separating it from the Vavau Plateau. It is separated from the Namuka Plateau by a narrow channel with over 300 fathoms of water.

The northernmost plateau of the broad ridge of the Tonga Islands is the Vavau Plateau. This is elliptical, with a long tongue extending on the eastern face of the ridge toward the northern point of the Hapai Plateau, ending in isolated banks (the Disney and Falcon banks), lying to the northward of the broad channel, with over 400 fathoms separating it from the Hapai Group. The Vavau Group is by far the most picturesque of the Tonga Islands. It consists of the principal island of Vavau, extending across the northern part of the Vavau Plateau. Several parts of the island of Vavau are finely terraced; four terraces are indicated there, and other flat-topped smaller islands show traces of two or three terraces. The northern edge rises to a height of more than 500 feet, and slopes in a general way southward and inland. The southern shore is deeply indented by bays and sounds and flanked by innumerable islands and islets, some of considerable height (150 to 250 feet), which gradually become smaller and smaller as they rise toward the southward and eastward, these islands having been formed from the denudation and erosion of the greater Vavau. They form tongues of land and sea and sounds of all shapes and sizes, showing the traces of the former land connections of the islands and islets and their disintegration on the eastward and southward by the action of the sea. The islands and islets to the southward of the main islands rise from more or less extensive reef flats which stud the whole plateau, and on which corals grow in great profusion (mainly Millepora, Porites, Pavonia, Pocillopora, Fungia, and Astrea), to a depth of 5 to 6 fathoms in the sound. In the Namuka Group they extended in the more open waters to 14 and 16 fathoms.

It is evident that in the Tonga Group, which is a very extensive area of elevation, the recent corals have played no part in the formation of the masses of land and of the plateaus of the Tonga Ridge, and that here again, as in the Society Islands and Cook Islands, both also in areas of elevation, they are a mere thin living shell or crust growing at their characteristic depths upon platforms which in the one case are volcanic, in the other calcareous, the formation of which has been independent of their growth.

We expect to leave for the Ellice, Gilbert, and Marshall islands as soon as we can coal and refit.

A. Agassiz.

*THE OCCURRENCE OF APTOSOCHROMATISM IN PASSERINA CYANEA.**

The following remarks upon the Aptosochromatism of *Passerina cyanea*, although of insufficient importance to establish the phenomenon of color change without moult as a constant occurrence in the species, are conclusive enough, I am convinced, to prove the possibility of such a change, and are merely offered as such for what they may be worth.

Individual error and dogmatism have greatly retarded honest effort in this most important branch of ornithological science. It is a singular fact that certain individuals have conceived the idea that a feather once having passed its premature condition is utterly disconnected with the vital system of the bird, and such individuals cling to this belief with a tenacity wonderful to behold. They do not tell us, by the way, how it is that certain species of birds lacking external sebaceous glands manage to present as bright plumage as their allies so provided. Doubtless they may attribute the presence of oily matters upon the surface of the feathers of those species in which these glands are wanting to osmotic action; but admitting this, why not admit Aptosochromatism?

In his article on alleged changes of color in feathers (Bull. Am. Museum Nat. Hist. 1896), Dr. Allen compares a feather to a green leaf, which when once formed, cannot extend its growth to repair any injuries which may arise from insects, etc. This simile might well be carried yet farther and to better advantage. When the later summer or early fall approaches, certain leaves undergo a complete change in color, resulting in the beautiful colors of our September and October woods. The history of the underlying phenomena of autumnal coloration in leaves is very obscure, yet no one doubts the occurrence of the change for an instant. So it is with Aptosochromatism—the individual feathers undergo in many cases complete color changes, and although the underlying processes of these changes may be obscure, the fact of their presence is to my mind undeniable.

At the present time Aptosochromatism has not progressed far enough to encourage one to take up in detail the systematic occurrence of the color change in our species of native birds. It seems evident that for the present, attention should rather be devoted to endeavoring to demonstrate its fundamental principles, without which no science is firm, plainly evident as may be its happening.

Passerina cyanea, apart from its seasonal fall moult by which the plumage acquired in the spring is changed for the duller garb of the fall, doubtless exhibts two forms of Dichromatism, a term whose proper place, I hope, is now recognized as the fundamental term for the complex phenomena of double coloration. As I shall direct my attention toward proving that Aptosochromatism is concurrent in the species, and Ptosochromatism in the present paper will play an inconspicuous part. Both are compre-

* Read before the Nuttall Ornithological Club of Cambridge, Mass., June 5, 1899, with exhibition of the bird worked upon.

hensive terms, by the way, coined by Dr. Coues. The latter term may be defined for convenience, as the occurrence of Dichromatism depending entirely upon the loss of old feathers which are replaced by others of a different color. Both processes subserve the same general purpose and result in a seasonal change of color, in the present example, from that of the fall to the nuptial of the spring. The Ptosochromatic change of the spring will not further be considered here—let it suffice to say that beyond doubt some indigo birds change color in the spring by completely, or nearly so, shedding their feathers. The change not due to such feather loss is what interests us at the present, and will necessarily be presented far from exhaustively. My remarks are based chiefly upon observations conducted during the fall, winter, and early spring of 1898–99, upon a captive male bird. In view of the color of the plumage of my bird, at the time I took possession of it, it must have been in the adult condition, and as such birds are commonly captured while in the adult state, the difficulty in adapting my bird to his captive condition and the heavy feather loss undoubtedly resulting from this may consequently, be explained. I secured it October 13th, while it was nearing the completion of its fall moult, which by October 28th was finished. From that date every cast-off feather was carefully collected and labelled. In order to be sure of obtaining all, a fender was placed about the cage and the room carefully swept at frequent intervals. In addition to this I made many examinations of the bird and secured such specimen feathers in a fresh state as I wished for microscopic examination.

Briefly, the bird was fed mostly upon millet and canary seed, appeared healthy, bathed regularly, and during bright days sang frequently. On March 26th, however, he died after an illness of three days, before which he was as lively as ever. Examination showed constipation to be the probable cause of his untimely death. The color change had progressed excellently however, and but little additional information could have been gained had he lived, excepting the period of time occupied by the entire change. Data is present in sufficient quantity, nevertheless, to enable me to state the time occupied by the change in certain portions of the plumage.

The appearance of my bird as regards color, October 28th, was as follows: Feathers of the head and breast slightly tinged with cobalt, the chief color of the feathers being dull rusty. The breast thus was somewhat mottled in appearance. Back rusty, the concealed centers bluish. Primaries and rectrices blackish with blue edges. Secondaries and coverts broadly edged with rust color. Lower abdomen buffy, ventral area whitish.

From October 28th till January 28th I observed no marked color change, but from February until the bird's death, it was very noticeable. A curious and undoubtedly unnormal process intervened however, and in order to understand this comprehensively I will tabulate the feather loss beginning with the first feather shed after October 28th, when it will be recollected that the bird had completed its moult.

Nov. 1,	1	contour	
" 7,	1	"	
" 12,	1	"	
" 21,	2	contours	
" 22,	1	contour	
" 25,	2	contours	
" 29,	1	contour	
Nov. 30–Dec. 5,	4	contours	
Dec. 5–11,	4	"	
" 11–24,	20	"	
" 24–31,	12	"	
Dec. 31–Jan. 7,	11	"	
Jan. 7–23,	3–5	"	daily
" 24,	12	"	
" 25,	16	"	
" 26,	13	"	
" 27 and 28,	61	"	
Jan. 28–Feb. 11,	34	"	

From February 11th to February 28th an average of 50 contours was lost daily. By March 5th the loss had abruptly ceased, and until his death on March 29th the bird lost but one or two feathers daily. The loss of down feathers was very small, not exceeding twenty specimens—a fact of possible importance to be dwelt upon later on. The total summary of the contour feathers lost, carefully estimated at 1350 feathers, appeared to comprise about three-fifths of my bird's entire plumage. They were shed from all parts of the plumage, and in view of the heavy loss I was quite prepared to ultimately conclude that any color change resulting in my bird would ensue from extensive feather loss. I was thus quite unprepared for what eventually followed. Microscopically, the cast-off feathers were broken, abraded and apparently in the worst condition. The barbules were broken or wanting, the barbs in many places worn down, and the rhachis of the larger feathers was split. This is also of importance as will directly be seen. To many observers my bird by March 5th would have been pronounced to be completely moulting. Immature feathers were in prominence especially upon the head and were scattered all about the remaining feathers of the plumage, which, as has been before remarked, amounted to about two-fifths of the entire plumage. The color of a discarded feather, compared with a freshly plucked one from the body, showed in most cases a decided contrast. Not only were the blue portions dull but their superstructures were gone in many cases, the feathers then being dull brownish. A probable, and, as I am convinced, the truthful source of my bird's extensive loss is found indirectly in the temperament of the bird. From the very first it was fretful and timid, fluttering wildly when uncovered in the morning or when the cage was cleaned out. Even an approach in his direction while hanging in the room caused a wild fluttering. Upon such occasions many feathers would be shed, and those remaining were more or less injured. Thus when such a vital process as Aptosochromatism begins to work, these decrepit feathers necessarily would have to be renewed in order to take part in the general plan. The head upon which many pin feathers appeared, naturally received a considerable share of the injury as regards its feathers, and the tail was in a very bad state.

It will be noticed in the table how gradually the loss began, due doubtless to the gradual approach of activity towards color change in the feathers. It must be admitted that this explanation is purely hypothetical, but such a hypothesis, although not of fundamental importance, ofttimes prepares the way for a clearer understanding of the problem under consideration. The small loss of down feathers points in two ways to the truth of this assumption. Firstly, being more or less under the contour feathers they received less of the wear caused to the others, and secondly, having no color change in themselves, their part in the color-changing process was inconspicuous. It is not probable that the bird could have swallowed many down feathers without it being observed in the excrement.

As I frequently examined the bird closely I noticed at once that the developing feathers which were supplying the places of the cast-off ones, far from appearing to change the color of the bird to blue, were actually coming true to the colors in which they were shed, *i. e.*, in the colors of the fall plumage. To be positive I collected and examined extensively and in every case verified this most interesting principle. It will be recollected that in my observations upon the Aptosochromatism of *Chrysotis Levaillanti* (see *Osprey*, III., No. 8, April, '99), similar results were noticed. In later dates a few parti-changed feathers were found in the embryonic condition, but these may be readily accounted for in two ways, for in no cases were fully changed feathers so detected. (1) Where a partially changed feather had been pulled out or shed and was being renewed, and (2) where a feather had begun to change before it was matured (this being noticed in my parrot investigation). Many of the contradictory and confusing remarks of dealers in birds may perhaps be explained by these most important observations, and it may readily be true that more than a few instances of so-called color changes depending upon spring moults in cage birds, may be due to extensive feather losses precedent to an Aptosochromatic change.

It seems unnecessary to dwell upon the fact that no vital process can readily take place in a greatly injured organic structure, and the renewal of my bird's feathers concurrent with the approach of the macroscopic activity of the color change is, I think, an incident of no little value.

The first appearances of a color change were noticed in some of the old feathers of the crown during the first week of February. Here a brightening of the blue area of the feather was noticed but no perceptible change of color at the tips where the russet was. From this date till the death of the bird a slow but constant change occurred, chiefly noticeable on the rump, throat, and breast. The first indication of the approach of the change externally was the brightening of the blue portion of the feather, beginning evenly on each vane from the bottom. When the band of tawny was reached, it appeared slowly to be absorbed until but faint tips of this color could be seen upon the ends of the larger barbs. In no cases were the barbs or barbules broken off sufficiently to account for the change. A loss of one-third of the length of the feathers in many cases would have been the result, and close observation did not sustain this in the least. I was enabled to notice the change in certain breast feathers, which was much more rapid than that of the parrot before referred to. Yet in the latter case the change which gradually causes the yellow plumage is a slow one of life duration, and but few feathers are involved at a time. That of *Passerina cyanea* is one of comparatively short duration and involves the greater part of the entire plumage.

Upon his death the bird presented the following appearance as regards color. An irregular area of brilliant cobalt blue extended from the throat to the belly down the center of the breast, the feathers upon each side graduating gradually to the sides, where but little change had occurred. Head partially changed in parts, inter-scapulars not perceptibly changed at all (a place where many pin feathers formed). Back altered slightly, rump and scapulars $\frac{2}{3}$ changed to bright greenish blue, the long russet tips almost entirely changed in some feathers, wings and tail unaltered with the exception of the secondaries and coverts, which had slightly changed on the edges. Throat slightly blackish, lower ventral region as with the rump. Assuming, as we safely may, that the first of February marked the beginning of the macroscopic change, we may attribute the total length of time occupied in the change of some of the breast feathers, from the fall to the spring colors, to a period of about fifty days, which for some of the feathers is an over-estimate.

It is not a little curious that the feathers should act so independently and especially so when it is considered that each feather comes true in color.

While skins of birds may serve highly important purposes, it appears essential that for good results in investigations upon color change, one should operate rather upon live birds in confinement. It is quite absurd to suppose that a single generation in confinement would so alter the natural laws of the organism as to obscure Aptosochromatism or Ptosochromatism, if one process or the other be a natural tendency. It is objectively certain that the phenomenon of Aptosochromatism occurs widely, but whether of individual or specific occurrence is not yet clearly shown. While my bird threw out no hint whatever as to the constant occurrence of the color change, it did prove that the 'impossibility' is possible.* It is certain that the heavy feather loss of my bird but indirectly helped the change; 1st, we have seen that many feathers changed which were not renewed by moult; 2d, we saw that those feathers which were renewed by direct gain and loss were colored similarly to those which preceded them, but that later on they changed Aptosochromatically, and 3d, no purely blue, *i. e.*, changed feathers, were found in an embryonic condition at any time, although frequent careful examinations of the bird were made.

Although it is of no positive certainty whether, in the new feathers, the vascular connection with the body was severed, it was found that their complete form was attained in most cases a week or more before a change set in; and in those unshed feathers carried over from the fall, it is quite reasonable to suppose that all connections with the body of the bird were as normal as in other feathers of a similar age. Before the change of color had begun, in December or January, in specimens examined carefully under the microscope, I could detect no presence of carrier pigment cells and found the calamus of each feather to be in the expected dried up condition. The change would thus seem to be confined to activity in the feathers alone.

* Dr. Chadbourne has informed me, since the above was written, that of three confined male indigo birds observed by him, two changed color ptosochromatically and the third 'without any feather loss to speak of,' *i. e.*, aptosochromatically; and still later on, I was delighted to learn during a conversation with Mr. C. J. Maynard that he too had followed a male *Passerina* through its entire spring change of color. The bird involved, belonged to a friend of Mr. Maynard, who informed him that the bird had changed its colors during the season just passed without moulting its feathers. Determined to follow out the change exactly, Mr. Maynard examined the bird frequently the next season, throughout the entire time occupied by the change, and perfectly satisfied himself that it was totally unassisted by a moult or any considerable loss of feathers.

In a brief summary of the principal points already discussed in connection with my bird we may conclude (1) that Aptosochromatism in my *Passerina cyanea* occurred beyond doubt, (2) that although present with severe feather loss it does not follow that the gain of color was directly responsible to it, as proved by careful examination of the newly acquired feathers, and (3) that although the feather loss was objectively independent of the Aptosochromatic change, it might subjectively be so, inasmuch as old and imperfect feathers were renewed for active and healthy ones, in which such a color change subsequently occurred.

The results quoted of Dr. Chadbourne and Mr. Maynard appear to me to be conclusive in themselves and require no further comment. Microscopically, the color change was not of as much prominence as might have been expected at first thought, but it will be recollected that blue and violet colored feathers depend, in a large measure, for their effects, upon involved objective superstructures, which act in combination with some underlying pigment or pigments. These pigments produce chemical objective effects, due to the absorption of all light rays not depending upon the characteristic color of the pigments.

Chemically and microscopically, the feathers of my *Passerina cyanea* appeared to contain two pigments, one, a diffused non-granular tawny colored stain, the other, a granular blackish substance. The yellowish stain was confined to the transparent sheath of the barbs and to the barbules, while the granular matter varied in placement with the color of the feathers.

An unchanged, *i. e.*, fall-colored feather, examined in a fresh state, exhibited the following appearance under the microscope. The rhachis appeared, centrally, to be cellular in construction with an enveloping sheath thickly supplied with the black pigment matter, the granules arranged in an order suggestive of a streaming movement toward the tip of the feather. At the junction with each barb a small portion of the main system curved upward into the central portion of that member. Proximally this column ended in the modification of the rachis into barbs. The center of each barb of the colored parts of the feathers contained a prismatic column, resembling to my eye, a number of bodies set together so as to resemble the nodes and internodes of a bamboo cane. At the distal end of each barb these bodies tapered, and in many cases the extreme joints were separated from the main column. About the blue portions of the feathers, these columns were massed thickly with black matter, the portions giving the rusty effects being much less plentifully supplied, and surrounding this central column a transparent envelope of the yellowish stain was present. The barbules of the non-blue area were the color of this sheath but became well supplied with the dark pigment when the blue-producing area was met with, completely obscuring the presence of the stain. The tips of the prismatic columns showed a pale brownish orange color, but gradually as the microscope slide was passed across the stage the color became deeper until when one-half of the length of the barbs had passed before the objective, it appeared deep black.

The blue area of such a feather gave a good reaction for Zoomelanin (black), for by boiling the feather in KOH, 0.5% and then heating with chlorine, the dark matter was completely broken up, and the feather appeared colored as with the rusty-colored tip which was apparently unaltered by the test.

When compared to a feather wholly changed to blue by the Aptosochromatic process, a valuable suggestion is at once thrown out, as to the nature of the change of color. In a microscopic examination of such a feather it is noticed that the lower parts of the central barb colums were as in the bicolored-fall feathers excepting that the massing of the black appeared to be denser. The upper parts however which were deep orange brown before, varying to lighter tints as the tips of the barbs were approached, now appear thickly massed with the black also, and the yellowish barbules are likewise colored. The streaming movement of the color granules is now especially prominent in an actively changing feather, and it readily appears that the rhachis gives up a part of its matter to the barbs, which in turn supply it to the barbules. A positive change of pigment is manifested macroscopically, for a fall feather held to the light or crushed, remains yellowish in its yellow-colored parts, while a spring feather, appearing entirely blue, so treated, shows darkly, due to the addition of black pigment.

Undoubtedly the blue effects are produced by the prismatic column in coöperation with the dark involved pigment, the sheath enveloping these parts playing its part with the barbules in producing the fall-colored feather. A cross section of the blue-producing barb sustains this view. When placed under the microscope with all light obstructed, but that descending to the stage from above, the sheath became invisible but the central column showed up like phosphorus as a pale glimmering blue which became opalescent with the varying quantities of light admitted. Unsectioned feathers so treated acted quite similarly, but the parts of the column appearing in the tips of the fall feathers, instead of betraying blue, showed gleaming white effects. Under transmitted light, as in ordinary examinations, the effects of the pigments alone were seen.

The massing of the granules of pigment begins evenly upon each vane, from the bottom of each barb and works towards the tips, the barbules being filled, from the tips first, as they are passed. The tips of the distal barbs usually were the last to completely undergo this change.

In both fall and spring feathers, the objective superstructure occupied the same relative position, being confined to the center of the barbs alone for almost their entire lengths.

Dr. Gadow, who has published results of his investigations upon the nature of the blue-producing structures in feathers, concludes that the production of blue is, in a measure, caused by the fine ridges of the prismatic columns, and thinks that the bodies of the columns and the transparent sheaths of the barbs may exert an appreciable influence. He adds in consequence "the production of blue therefore in a feather would be the result of a very complicated process."

As shown in my feathers, however, the blue appeared to be largely independent of the envelope of the barbs, yet this might concentrate light rays or so modify them that the consequent would be helpful. One thing appears certain, that to the presence of quantities of granular black-like matter is due no small share of the ultimate production of blue.

The causes of the differences in the shade of the blue feathers from violet to greenish, according to their position on the bird, appeared to be very slight microscopically, and I could detect no constant characters with the facilities at my disposal.

As to the causes of the activity necessary to produce a color change, we may only infer. As proved by dissection my bird was not undergoing any prominent sexual change, and the theory that the temperature of the atmosphere might be responsible would not be applicable to most cage birds which are kept in warm rooms. There can be no doubt, however, but that the fall change of plumage is one of protective tendency, and it is highly possible that until changed in the spring, the feathers, in a certain sense, are immature. In the case of the double yellow-headed parrot before mentioned, the color change was of a retrograde nature, but in the present example the process is synthetic rather than otherwise.

Numerous theories have been published which endeavor to account for the dichromatic fall change of many birds, but it would be irrelevant to discuss them here. One thing appears certain, that the process is deeply involved in the vital system of the organism. Professor Beddard cites an example noticed by Professor Weber of a chaffinch which was so colored that one-half of the bird was in the male plumage and the other portion in the female. Dissection proved the bird to be a Hermaphrodite, *i. e.*, the side sustaining the male plumage was found to contain a testicle, while the opposite portion of the body possessed an ovary, and Professor Beddard writes that this curious abnormality had been noticed before.

As no vascular connection appeared to be present in the perfect feathers of my bird, the change appears to be one of internal activity in the feathers themselves, and the simile before mentioned, of the autumn leaf, appears to be still more strongly consistent. The change is none the less vital, however, and ceases with the death of the organism. No tests delicate enough were applied to determine if new matter was formed directly in the feather. It appeared probable that none was, but that the striking change depended upon the massing of the dark granular matter from the rhachis to the barbs and their appendages. The absence of definite data upon the chemistry of animal pigments makes remarks in a qualitative direction wholly undesirable.

To conclude our microscopic study, however, we may affirm: (1) that microscopically as well as macroscopically an appreciable Aptosochromatic change took place in the individual feathers of my *Passerina cyanea;* (2) that this change far from being analytical or retrograde was inclined to the nature of constructive synthesis, probably passive in nature; (3) that the change was definite as shown by comparison with the blue areas of unchanged feathers; (4) that it depended chiefly upon the gain of dark pigment in the vicinity of the prismatic column, and (5) that there was an appreciable difference in the amounts of blackish pigment supplied to the barbs and barbules, before and after the change.

F. J. Birtwell.

Albuquerque, New Mexico.

THE SOCIETY FOR PLANT MORPHOLOGY AND PHYSIOLOGY.

The Society for Plant Morphology and Physiology held its third meeting, with the American Society of Naturalists and the Affiliated Scientific Societies, at Yale University, New Haven Conn., December 27th and 28th, with President J. M. Macfarlane in the chair. For the ensuing year the following officers were elected: *President,* D. P. Penhallow; *Vice-Presidents,* Roland Thaxter and Erwin F. Smith; *Secretary,* W. F. Ganong. The following new members were elected: Oakes Ames, J. M. Coulter, Carrie M. Derick, B. M. Duggar, A. W. Evans, M. A. Howe, L. R. Jones, Henry Kraemer, F. E. Lloyd, D. T. MacDougal, Conway MacMillan, G. T. Moore, Adeline F. Schively, Hermann von Schrenk, Julia W. Snow. The business transacted of most general interest was the appointment of a committee, consisting of W. G. Farlow, D. T. MacDougal and H. von Schrenk to consider ways of securing better reviews of current botanical literature. It was voted to communicate the views of the Society upon this subject to the editors of the *Botanisches Centralblatt.* The following papers were presented. The abstracts are furnished by the authors.

Geotropic Experiments: Dr. G. E. Stone, Massachusetts Agricultural College.

This paper dealt with the question at which angle gravity acts most strongly on a geotropically sensitive organism. The results were obtained by the use of grass nodes and in one or two instances the roots of *Vicia faba* were used. Three methods of experimenting touching upon the solution of this problem were described.

The first series give the results of dynamometer experiments in which the power of growth shown by different nodes placed at different angles was illustrated.

The second method consisted of taking the average of a large number of cut plants grown in moist sand and placed at different angles.

The third method showed the results of experiments due to the after effect of stimulation.

The results of all these experiments were similar and may be partly summarized as follows:

The horizontal position is the position of greatest geotropic excitability. This is shown by the increased amount of weight nodes will lift in this position, the amount of growth they display and the after effect reactions.

The relationship existing between nodes at oblique angles and those in a horizontal position is one which is proportional to the cosines of their angles. This also holds good when the nodes were placed at angles below the horizontal position. Young nodes show a definite response to geotropic stimulus when exposed for so short a period as 30 seconds. The latent period is about 30 minutes long.

On the embryo sac of Saururus cernuus: Dr. D. S. Johnson, Johns Hopkins University.

The development of the bract and flower is essentially like that found in the Piperaceæ by Schmitz. In the material studied there were two ovules to each carpel, of which only one, the upper one, matured to a seed. There are two integuments as in most of the Piperaceæ and both grow up to form the micropyle. The primary archesporial cell is single and hypodermal in position. It divides to a definite archesporial cell and an upper tapetal cell. The former then divides to three potential macrospores, of which the lower only becomes functional. This grows and the nucleus divides in the usual way to form a seven nucleate embryo sac. The embryo sac soon widens at the base to become flask-shaped, with the egg apparatus at the upper end of the neck and one endosperm nucleus in the neck and probably a second one in the body of the flask. The antipodals soon become indistinguishable, probably degenerating. Endosperm cells are formed in the neck of the flask before any change can be seen in the egg itself. In the ripe seed the endosperm is found to have swelled laterally using up only the tip of the large nucellus while the lower or body end of the embryo sac is still without endosperm cells or nuclei. The features of the development of *Saururus* thus far studied give no conclusive evidence of its primitive character.

Upon the best way of securing a good review of Current Botanical Literature: Professor W. G. Farlow, Harvard University.

Professor Farlow's address upon this subject appeared in synopsis in the *Botanical Gazette* for January. He pointed out that this is a question distinct from that of a card catalogue, international or other, of literature. None of the existent journals fully meets the needs of botanists for prompt descriptive synoptic reviews of current literature. The *Botanisches Centralblatt* comes the nearest to the needed journal, and if its reviews were more prompt, and, in many cases, of a more descriptive character, and if it did not take up with original articles so much space which ought to be given to reviews, thus forcing many of the latter into Beihefte for which an additional subscription must be paid, it would be much more satisfactory. The discussion following this paper showed that similar opinions are held generally by botanists in this country, and steps were taken to communicate the Society's opinions upon the subject to the editors of the *Centralblatt.*

Fasciation in the Sweet Potato: Mr. Henry S. Conard, University of Pennsylvania. (By invitation.)

The author stated that typical fasciations $\frac{1}{2}$ in. to 3 in. broad are common in the sweet potato. The internal structure of these differs from that of normal stems only in the shape of the cross-section. On poor soil 12% of the stems are abnormal, on good soil 18% ; counting apices only, 20% are abnormal on poor soil, 54% on good soil. Of the abnormal stems $\frac{1}{2}$% to 1% are ring-fasciated. Such stems enlarge gradually from the base, but maintain a round cross-section. They become hollow within, the cavity opening to the air at the growing apex. The apex has a wavy margin; or the tube may be split above, and may give rise to plain fasciation. The tubular portion may be as much as 2 or 3 ft. long by $\frac{1}{2}$ to $\frac{3}{4}$ in. in diameter. The cavity has on its walls acropetally developed leaves, and adventitious roots; the latter become functional when cuttings of the ring-fasciation are planted. The transverse section shows two bundle-systems, an outer normal one, and an inner surrounding the cavity with its normal phloem facing the cavity. The hollow is bounded by epidermis and cortex. Internal phloem (bicollateral structure) is a marked feature of both internal and external bundle-systems of the ring-fasciated stem, as it is of the normal stem. The two bundle-systems of the anomalous specimens are entirely separate, but merge into common ring-shaped apical meristem. Toward the root the cavity tapers to a close, leaving a ring of bundles; these dwindle away one by one, the phloem elements persisting longest. The writer's observations agree essentially with similar ones of de Vries and Nessler; he also considers Masters' 'tubular stem of Sempervivum' and Qualch's 'fasciated sweet-pea' as probable cases of ring-fasciation.

Leaf Scorch of the Sugar Beet: MR. F. C. STEWART, New York Experiment Station.

During August, 1899, some fields of sugar beets in Central New York were severely injured by sudden scorching of the foliage due to excessive transpiration. The foliage, wholly or in part, turned black and died. A majority of the affected plants recovered and made a second growth, but some were killed outright. The dead roots showed internal browning around the circumference and dark colored, raised, somewhat V-shaped areas on the surface. Later in the season the raised surface areas became affected with dry rot and the dead tissue was eaten away by millipedes, leaving shallow cavities resembling scab spots. It has been proved by an inoculation experiment that the internal browning is not caused by parasitic organisms. All affected beets were low in sugar content.

This paper has been published in New York Agricultural Experiment Station Bulletin, No. 162.

Distribution of red color in vegetative parts in the New England flora: MISS F. GRACE SMITH, Smith College. (By invitation.)

The author called attention to the various and more or less conflicting views as to the meaning of the presence of red color in vegetative parts of plants. In order to test these theories, observations were made to determine how many plants in the New England flora show the red color. Careful account was taken of the exact structural part in which the color occurs, and of the relation of the position of the color to external conditions of light, dryness, etc. The results were reduced to percentages and showed that none of the existent theories will explain the distribution of the color in our vegetation. The conclusion is drawn that either the red color must have several different reasons for being, or else it has some significance to which we as yet have no clue. The studies are to be continued.

On the morphology of certain plants from the Devonian of Europe and America: PROFESSOR D. P. PENHALLOW, McGill University.

The author drew attention in particular to two types of plants which had been the subject of investigation for a number of years.

In 1831 Fleming described certain interesting and peculiar fossils from the Devonian of Scotland under the name of *Parka decipiens*, and subsequently Hugh Miller gave them much consideration in his Old Red Sandstone. Since that time they have excited the interest of paleontologists at various times, but always with reference to the eggs or spawn of some animal form of life. In 1891 they were first clearly proved to be of plant origin by Dawson and Penhallow, who, however, were unable to clearly establish their relations to existing types. So far as investigations have proceeded, we can now recognize a sporocarp enclosing both macro- and micro-sporangia, from which may be obtained the corresponding spores with dimensions of 40 and 15 microns respectively. Prothalli in various stages of development have also been obtained. There is presumptive evidence that the sporocarp may have been stalked as in Marsilia, but the character of the contents points more to an affinity with Pilularia. The association of creeping rhizomes strengthens the supposition that they were aquatics of the general habit of growth of Marsilia and Pilularia, while the recently discovered occurrence of leaves of the general type of Marsilia would seem to add to the validity of this hypothesis. Although closely and constantly associated in the same beds, and even on the same slab, the unfortunate separation of members will not permit final conclusions as to the nature of this plant at the present time.

In 1885, the late Sir William Dawson discovered in the Devonian sandstones of Gaspé, the remains of a gigantic alga to which he subsequently gave the name of *Nematophyton.* This genus has since been found to have a very wide distribution, being found in Great Britain, Germany, and various parts of the United States and Canada as far west as Ohio. At present eight species are distinguished, but it is highly probable that with a more complete knowledge of the plant, this number will be greatly reduced, while the number of genera may have to be increased.

They were plants of arborescent habit, attaining a diameter of two feet or more and a height which was undoubtedly great, but which can only be conjectured from the diameter and the fact that the largest specimen so far recovered from the Hamilton Group of New York, although incomplete, had a length of 24 feet. No foliage or fruit has yet been obtained, and our only guide to relationship is through the character of the internal structure. A pseudo-exogenous structure, as in many Laminarieæ, is conspicuous. Isodiametric, radial or irregularly branching openings occur in the various species, and in these areas or in their immediate neighborhood, the larger cellular elements branch more or less freely into small hyphæ which form an intercellular plexus. The principal elements of structure consist of exceedingly long, non-septate, thick-walled, tubular cells which traverse the stem in the direction of the longitudinal axis—though to a minor extent transversely—and interlace freely to form a medulla as in the larger forms of the Laminarieæ. No surface markings of the walls have been observed, but in one species (*N. Ortoni*) the cells show local enlargements closely resembling the trumpet hyphæ of *Macrocystis.*

One of the most instructive features of these plants is to be found in certain structural modifications which they exhibit. In working up material from various sources, it was discovered that many specimens exhibited certain transitional forms from normal structure to what was described many years since by the late Sir William Dawson under the name of *Celluloxylon primævum.* A closer study revealed the fact that this alteration was incident to the crystallization of the infiltrated silica and the operation of decay, whereby the carbon particles of the original cell walls were redistributed upon the surfaces of the crystals in such a manner as to produce the general effect of a coarse cellular structure.

Notes on the morphology and reproduction of Chlorocystis Cohnii: Mr. G. T. Moore, Dartmouth College. (By invitation.)

The structure and development of this unicellular alga growing on Entromorpha was described and several points differing from those previously recorded were referred to. It was shown that the habit of the plant is not that of a universal endophyte but is quite as often merely epiphytic. The character of the chromatophore was found to vary from the 'one-sided' arrangement, considered by Reinhard as typical, to a condition where the cell wall was completely lined by the color body. Two sizes of zoöspores, formed by successive divisions, were described, but no suggestion of conjugation could be observed and it seems probable that nothing of the kind occurs. In the material examined the discharge of zoöspores was found to take place through a circular opening of considerable size instead of through a tubular neck as recorded by European writers on this subject. The paper will be published in full later.

The roots and mycorhizal adaptations of the Monotropaceæ: PROFESSOR D. T. MACDOUGAL, New York Botanical Garden, and PROFESSOR F. E. LLOYD, Teachers College. (By invitation.)

The Monotropaceæ have been under investigation with respect to their mycorhizæ since 1840. Of the genus *Monotropa*, *M. Hypopitys* only has received consideration, and all references made in text-books hitherto have referred to this plant. *Monotropa uniflora* has now been added to the list. In this plant the roots are found to be entirely invested by the mycelium of the fungal symbiont, even over the cap. The latter is 2–4 cells in thickness but arises from a calyptro-dermatogenic layer. The plerome and periblem arise from a common initial tissue and may not be distinguished for some distance back from the apex. The stele and cortex arising therefrom are not distinctly delimited, there being no well marked endodermis. The stele is very irregular in structure. The hyphæ of the fungus gain access to the epidermal cells at about the backward limit of the root-cap, but never enter these. The short haustorial branches which gain entrance enlarge into more or less irregular vesicles, and these come partly to surround more or less the nucleus which, however, does not become hyperchromatic, but maintains its normal condition for a long time. The epidermal cells ultimately become separated from each other by the hyphæ which penetrate between them, but not between the cells of the cortex, or only very rarely. The vesicles sometimes produce spore-like bodies and are believed to be reproductive. A most interesting gradation from the arrangement of the mycorhizas in the nearly related *Pyrolas* is shown. The branching of the root in *M. uniflora* is exogenous, this result not according with that of Kamiensky on *Hypoitys*.

The general statements which may be made concerning all the Montotropaceæ now studied with reference to their mycorhizas are as follows:

1. The shoots are free from chlorophyll, and have no stomata except in the case of *Pterospora*.

2. The customary relations in size of the root and shoot are lost.

3. The stele is much reduced in both the shoot and root, and shows perforated vessels and companion cells only.

4. The fungus sheathing the root encloses the tip completely, at least at certain seasons, and penetrates the epidermal cells in all of the genera examined. Vesicles, sporrangioids or organs of interchange are formed in the epidermal cells. The relation between the fungus and the seed plant is a pure symbiosis and the latter does not act as a fungus trap in accordance with Frank's theory.

5. The root cap is one to many layered, and with the epidermis is derived from a dermato-calyptrogenic layer. The periblem and plerome are not distinguishable in form or content.

The structure and reproduction of Compsopogon: Dr. Roland Thaxter, Harvard University.

The author gave some account of the distribution of *Compsopogon* in Florida, mentioning the localities where it had been found by himself and others, in fresh as well as partly tidal waters. Its general structure was described, attention being called to the fact that the older filaments may possess a cortex of from two to four layers of cells. Details of cell structure and the normal reproduction by aplanospores were illustrated, as well as the formation of small aplanospores developed from sorus-like groups of superficial cells.

On some diseases of New England Coniferæ: Dr. Hermann von Schrenk, Shaw School of Botany. (By invitation.)

The coniferous woods of this region are being destroyed by the mycelia of a number of fungi, chief among which are, *Polyporus tenella, Polyporus Schweinitzii, Polyporus piceinus, Polyporus pinicola, Polyporus sulfureus* and *Agaricus melleus.* The mycelia bring about characteristic changes in the wood either by destroying the lignin and leaving pure cellulose, or by transforming the wood into a brown brittle substance. The changes are caused by enzymes one of which was obtained from *Polyporus tenella*, capable of destroying the substance hadromal, leaving pure cellulose. This enzyme is not diastase. The extent to which decomposition is carried on is apparently determined by decomposition products such as humus compounds, citric and succinic acids and others. These stop the action of the enzyme at a certain point. The enzyme transforms the wood in great quantities; many pounds of pure cellulose are often found in one place. Masses of cellulose and some hadromal were exhibited. The mycelia of these fungi live both as parasites and saprophytes, some entirely in the ground. The sporophores of many excrete manitose in quantity at the time when the spores are ripe. This may aid in the dissemination by attracting bark beetles. Six forms of wood destruction were described, and specimens and photographs of the same were shown.

Vegetative reproduction and multiplication in Erythronium: Mr. Frederick H. Blodgett, New York Experiment Station. (By invitation.)

The presence of underground runners in *Erythronium americanum* has been recognized for some time. The development of the runners, and especially of the bulbs which are formed from their terminal buds was published in 1895. In the present article the author describes the common origin within the bulb of these runners and of the annual bulbs of the mature individuals, as axillary buds between the base of the stem and the inner bulb scale. The development of the first bulb from the seedling is also described. It is characterized by containing the plumule instead of the normal foliage leaf and remains latent for a year. From one bulb, thus developed from a seed, the life cycle is shown to occupy not less than four years, probably six or seven years in most instances. During this interval runners are given off each year, usually three annually, resulting in a bed in five years of from six to nine plants for each seed, or ninety plants if ten seeds of a single fruit should survive all steps of the cycle.

Current problems in Plant Cytology: Professor J. M. Macfarlane. (Presidential Address.)

This address is expected to appear in abstract in Science.

The structure of starch grains: Dr. Henry Kraemer, Philadelphia College of Pharmacy. (By invitation.)

In the different text-books starch grains are represented as having either a light-colored point of growth (nucleus or hilum) with alternate dark and light lamellæ as figured in Sach's works or having a dark point of growth and alternate light and dark lamellæ as illustrated by Strasburger. The appearance of the grain as given by these and other writers is dependent upon the view of the grain by the observer. In focusing upon the top of the successive lamellæ of the grain, one observes the view as given by Strasburger; whereas if one brings the focus to the base of the lamellæ the appearance of the grain as given by Sachs is observed. If we focus upon the top of the various lamellæ of the potato starch grain, we find not only grayish and light colored lamellæ alternating with each other, but we find in the center of the grayish colored zone at the point of growth a much darker area. A layer having the same appearance as this dark area is also observed on the outside of one or more of the grayish lamellæ. The grayish and dark colored layers, just referred to, have a redish appearance, the dark colored layers being slightly bluish also.

Upon treating the starch grains with an aqueous solution of an aniline stain such as safranin, gentian violet, etc., the stain is apparently taken up by the darker lamellæ, *i. e.*, when focusing upon the top of the layers or lamellæ. On the other hand on treating the grains with chromic acid, calcium nitrate, etc., or with water at different temperatures for varying periods of time, the characteristic sphero-crystalloidal structure is brought out in the light lamellæ, *i. e.*, when focusing on top of the layers or lamellæ.

We find further that the layers which do not take up the aniline stains become blue with iodine, whereas the alternating layers are not at all affected apparently by this reagent. It appears that the layers not affected by iodine, but stained by the aniline colors, are rich in colloidal substances but poor in crystalloidal materials. These correspond to the cellulose layers of Nägeli, the farinose layers of von Mohl and the β-amylose layers of Meyer. The layers stained blue by iodine and not stained by the aqueous aniline solutions, are poor in colloidal substances but rich in crystalloidal materials, these corresponding to the granulose layers of Nägeli and von Mohl and to the α-amylose layers of Meyer.

The toxic action of a series of Sodium Salts: DR. RODNEY H. TRUE, Cambridge, Mass. (By invitation.)

From experimental results worked out by Drs. Kahlenberg and True, the latter formulated the results presented under this title.

After studying the toxic action exerted on roots of *Lupinus albus* by a series of acids and by their Na salts, in view of the ionization of these compounds, an analysis of their toxic action has been made into the partial-toxicities due respectively to H ions, anions and ionized molecules. In inorganic acids of the type of HCl, the action of the anions is so slight, relative to that of H ions, as to be thrown into insignificance. In the organic acids where ionization is usually much less advanced, the predominance of the H effect is less marked. In formic, salicylic, ortho-nitrobenzoic and protocatechinic acids, the H ions exceed in effectiveness all other factors. In propionic, butyric, gallic, cinnamic and hippuric acids the action of the unionized molecules predominates over all other factors. In the sodium salts where a greater degree of ionization exists, a greatly diminished toxic action is seen, due chiefly, apparently, to the action of the anions. In carbolic acid, having its hydrogen in the hydroxyl ($-OH$) form as contrasted with the above organic acids in which it exists as carboxyl ($-COOH$) hydrogen, ionization is at a minimum and the toxic action is due solely to unionized molecules.

Further notes on the Embryology of the Rubiaceæ: PROFESSOR F. E. LLOYD, Teachers College. (By invitation.)

The Rubiaceæ reported upon up till now include the *Stellatæ*. The present paper deals with *Diodia virginiana*, *D. teres*, *Richardsonia pilosa* and *Cephalanthus occidentalis*. All are similar morphologically as to the topography of the ovule. They vary, however, in the relative rapidity of development of the basal partition and of the nucelli. *Cephalanthus* possesses the most rapidly developing basal partition with the result that the ovule is rotated so that the funicle is inserted in the top of the ovary and the embryo sac is inverted. All possess an outgrowth of the funicle, resembling a second integument, which in *Richardsonia* and *Diodia* becomes loaded with raphides and is believed to have a nutritive rôle. The 'spongy' funicular appendage in *Cephalanthus* is shown to be the homolog of that in *Diodia* and *Richardsonia*, but the nutritive function is here less probable. The funicle in *Diodia* and *Richardsonia* is surrounded by a collar of peculiar epithelial cells which in *Richardsonia* are the path of the pollen tubes; the latter never travel freely in the ovarian cavity. The archesporium consists of but one cell which gives rise to four megaspores. One of these is the embro-sac mother cell. The embryo-sac is of the elongated type with the usual number of cells. One of the antipodal cells is rather long in *Diodia*, but the three are of equal size in *Richardsonia* and *Cephalanthus*. *Diodia virginiana*, however, has four antipodal cells from the division of the long cell after the small ones are cut off. The embryo possesses a short cylindrical suspensor from which the haustoria characteristic of the *Stellatæ* are absent. There is, however, evidence of a nutritive function. The embryo develops at first very slowly, in contrast with its rapid early development in the *Stellatæ*, a fact which is correlated with the absence of haustoria. The endosperm at first is parietal.

The stimuli that cause the so-called 'peg' or 'heel' on Cucurbita seedlings: DR. J. B. POLLOCK, University of Michigan.

No abstract of this paper is available.

On the prothallus of Taxodium distichum Richard: MR. W. C. COKER, Johns Hopkins University. (By invitation.)

The archesporium consists of a group of cells near the base of the nucellus. One of its central cells enlarges at the expense of those around it and becomes the embryo-sac. The archegonia arise at the upper end in a group and soon come to lie in a depression, which is at first covered over by the wall of the embryo-sac. There are four neck cells, and a ventral canal cell is cut off. Soon after the formation of its cell-walls the endosperm cells become multinucleate by amitotic division.

The pollen sprouts soon after pollination (which in Baltimore takes place about the middle of March) and reaches the embryo-sac before a solid endosperm has been formed. The end in contact with the sac now contains three nuclei, not greatly differing in size, one of which is the body cell nucleus. This increases in size, surrounds itself with a dense mass of cytoplasm, and just before fertilization divides into two male pro-nuclei each with its mass of cytoplasm. Several pollen tubes may push their much enlarged ends into the depression in the embryo-sac. The male and female pro-nuclei come in contact near the upper end of the oösphere and move towards its base. Fusion is complete about the time the base is reached. The young pro-embryo consists of four tiers of four cells each, the upper tier lying free in the archegonium.

A new type of branching in the leafy Hepaticæ: DR. A. W. EVANS, Yale University. (By invitation.)

According to Leitgeb, who made a thorough study of the various kinds of branching exhibited by this group of plants, his so-called 'Endverzweigung' or 'terminal branching' always occurs in the ventral half of one of the lateral segments cut off from the apical cell. In the curious *Mastigobryum integrifolium* Aust. of the Hawaiian Islands, this same kind of branching occurs in both lateral and ventral segments, showing that it is much less restricted than Leitgeb supposed. In this case the ventral branches, apparently from their place of origin, are specialized as flagella.

The geotropism of split stems: DR. E. B. COPELAND, University of West Virginia. (By invitation.)

Numerous experiments show that if a stem be split into two equal halves and then placed in a horizontal position, the lower half is stimulated to grow more rapidly than the upper. As compared with an erect half stem, the upper horizontal half (that with the split surface downward) has its growth depressed, while the lower horizontal half has its growth considerably more accelerated. This is what happens in an uninjured prostrate stem in the execution of a response to the geotropic stimulus, except that the difference in growth between the halves is much greater when they are separated.

It has been held that in the geotropism of stems there must be at least a transverse transmission of the 'sensation,' by which the halves can compare their positions; but in view of the behavior of the isolated half-stems this argument is obviously invalid.

Some variations and correlations in the leaves of trees: MISS HARRIET B. WINSOR, Springfield, Mass., and DR. W. F. GANONG, Smith College.

This paper, offered as an illustration of method, represented the results of an attempt to apply statistical methods to the study of an ecological problem, namely the factors determining the length of petioles and the size and shape of the leaf. The studies are to be continued.

Perennation in the stem of Lycopodium alopecuroides: DR. J. M. MACFARLANE, University of Pennsylvania.

The author pointed out that in this species the branch extremities begin to dip into the ground in autumn by what has been proved to be geotropic growth. This portion becomes colorless, greatly loaded with starch, and bears leaves that become specially modified from those of the normal green type. When the perennating part is fully developed it is a hook-like depression which lies dormant until the succeeding spring. By succeeding apogeotropic growth it again reaches the surface and assumes its usual development.

Of special interest is the fact that the above peculiarity is being gradually acquired, for while a large proportion of plants show it, a few that may grow protected in loose sphagnum or under water only show it to a feeble extent.

The phytoëcology of the Bay of Fundy salt marshes: DR. W. F. GANONG, Smith College.

At the head of the Bay of Fundy occur great salt marshes which bear a remarkably varied vegetation, showing transitions from the usual salt marsh to fresh-water bogs. The reclamation of the marshes for cultivation brings in another element, and all transitions may be found between the salt and the reclaimed marsh. These transitions of conditions afford an unusual opportunity to investigate some phases of the dynamical relationships of plants to their surroundings, and the author has attempted to work out this problem in ecology. The physical conditions of the marshes are discussed, the flora described and the segregation of the vegetation into formations illustrated. The physiological and structural peculiarities of the leading plants of each formation are then described. Finally an attempt is made to formulate the results into a series of principles of general application.

Complications in Citrus hybridization caused by polyembryony: Mr. H. J. Webber, Department of Agriculture.

During the last five years the writer has made about a thousand hybrids of the various species of *Citrus* commonly cultivated, and has had under his care and observation about an equal number made by Mr. W. T. Swingle. Last spring a careful comparison of the foliage characters of these hybrids led to the interesting observation that where two or three seedlings were developed from a single seed, as was frequently the case, they not infrequently showed marked foliage differences. The fact that the common orange and many other species of the genus *Citrus* are commonly polyembryonic is well known. A single seed of the common orange has been known to produce as high as thirteen different seedlings, although it is seldom that more than three of the embryos are capable of development. Strasburger, in his critical study of the polyembryony of this group, found that the embryos, other than that developed from the fecundated egg cell, are derived from certain cells of the nucellus lying near the embryo sac wall which become specialized, grow and divide rapidly, and form a tissue mass which pushes out into the embryo sac and forms an embryo similar to that formed in the normal way from the egg cell. The embryos formed in this way Strasburger called adventive embryos. If we correctly understand the action of fertilization it is clear that in hybridizing fruits of this sort only those embryos developed from the egg cell proper, as a result of the fecundation, would show an indication of the hybridization. The adventive embryos developed directly from the mother tissue we should not expect to show any of the characters of the male parent. This was the conclusion reached by Mr. Swingle and the writer jointly in discussing the matter several years ago, and the development of the hybrids has now shown this to be the case. In several instances of hybrids of *Citrus aurantium*, which has unifoliolate leaves, with *C. trifoliata*, which has trifoliolate leaves, where the former was used as the female parent, two and three seedlings have been produced from the same seed, one of which had trifoliolate leaves and the others strictly unifoliolate leaves exactly like those of the mother parent. In such cases it is evident that the trifoliolate seedling inherits this character from the male parent and that the embryo from which it grew was developed from the egg cell proper. The other seedlings in such cases, having unifoliolate leaves like the mother parent, are doubtless developed from the so-called adventive embryos. The writer has also observed the same phenomenon in the reciprocal hybrids, *Citrus trifoliata* ♀ × *C. aurantium* ♂, and in the hybrids of *Citrus nobilis* ♀ × *C. aurantium* ♂. The observations have been sufficiently extended so that we may be certain of the common occurrence of the phenomenon in citrous hybridization.

In hybridizing citrous fruits to secure improved sorts this fact unfortunately introduces a serious complication. The majority of citrous hybrids, in almost every case resemble the female parent in foliage characters, and it will thus be seen that until they fruit it will be impossible to determine whether they are true hybrids, showing a preponderating influence of the female parent, or simply false hybrids developed from adventive embryos. It is thus probable, or we may say certain that in such work many seedlings will have to be grown and fruited which are from adventive embryos and are not true hybrids. These of course cannot be expected to give rise to valuable new varieties, and growing them will greatly increase the trouble and expense.

W. F. GANONG,
Secretary.

SCIENTIFIC BOOKS.

Insects, their Structure and Life. By GEORGE H. CARPENTER, B.Sc. London, J. M. Dent & Co. 1899. Pp. 404, figs. 183.

There is need of a modern elementary text-book of entomology covering all the important phases of the study of insects. Comstock's Manual in its present form is chiefly devoted to the systematic and ecologic phases, while Packard's new text-book is given up exclusively to the morphological, physiological and developmental phases of insect biology. Mr. Carpenter's book is an attempt to supply the need. Its six chapters treat respectively of the Form of Insects (anatomy and, very slightly, of physiology), the Life-history of Insects (embryonic and post-embryonic development), the Classification of Insects, the Orders of Insects (these two chapters including the classification of insects as far as families, and brief mention of the habits with families as units), Insects and their Surroundings (ecology) and the Pedigree of Insects (phylogeny). These subjects include all the principle phases of the general biologic study of a group of animals, and in this respect the book is wisely planned to meet a real need. For the most part this presentation of the elementary facts of the 'structure and life of insects' will meet with the approval of teachers of entomology. The selection from the mass of material constituting the science of entomology of the little that can be included in an octavo volume of 400 pages, is a matter requiring a large knowledge of insects and a discriminating and clear pedagogic insight. The author (an active naturalist of Dublin) has a good knowledge of entomology, a discriminating perception of the relative importance of facts, and a clear and simple style.

In undertaking to write an elementary general text-book of entomology, the most difficult task is that of the satisfactory treatment of the systematic phase. The enormous number of insect species precludes the use in such a book of classificatory units smaller than families, and indeed renders the adoption of the family unit unsatisfactory. It is this part of the book, the chapter, Orders of Insects, devoted to the systematic consideration of insects, which is the least satisfactory part of it. To treat systematically the whole class of insects, using families as units, in a few more than one hundred octavo pages, and to impart to this treatment any real interest or life, or, one is forced to say, real value, is too nearly impossible to be expected from even the capable author of this book. He adopts a 15-order classification and races through these orders, leaping family barriers three or four to the page. To be sure, certain mechanical assistance, a resorting to small type, is offered to give each family a chance to have its habits told in two lines instead of one, but that hardly betters matters. There is simply no space for what is the absolute minimum of treatment necessary to make such a syllabus or synopsis worth anything more than a list.

It is with relief, therefore, that we leave this distressful attempt to do the impossible, to examine the following interesting and admirable chapter on 'Insects and their Surroundings,' where those general relations of insects to their surroundings, distribution, parasitism, protective resemblances and mimicry, social and communal life and other phases of insect ecology, are presented. Similarly good are the chapters on embryonic and post-embryonic development. Much of the matter of these chapters has never before been given in a small text-book of entomology, and that is the special value of this book. The illustrations are, while mostly good in themselves, often not very apposite to the context. Very few new figures have been made for the book. The excellent blocks (more familiar to American entomologists than they probably are to English students) of the Division of Entomology of the U. S. Dept. of Agriculture have been drawn on heavily for the book's illustration. One hundred and one out of the one hundred and eighty-three figures are from this source.

A brief but good bibliography is appended and there is an index. The work of printers and binders has been tastefully done. Altogether the book is a useful one, and one that can be recommended to beginning students of insects. VERNON L. KELLOGG.

STANFORD UNIVERSITY, CALIF.

The Strength of Materials. By J. A. EWING, Professor of Mechanism and Applied Mechanics in the University of Cambridge. Cambridge, The University Press. 1899. Octavo. Pp. 246.

It will be news to many Americans to learn that instruction in the subject of the strength of materials is now given at the University of Cambridge and that laboratory work in testing is done there. The mathematical theory of elasticity has long received attention at the universities of England and Scotland, as shown by the works of Todhunter and Pearson, of Love, and of Thompson and Tait; this theory and these volumes have, however, added little to the practical knowledge of the properties of materials and have not influenced engineering constructions. At last, after many years of waiting, there comes from Cambridge a book which recognizes the fact that observation and experiment are essentially necessary, and which sets forth the fundamental principles and facts in a manner likely to be of much value to the engineering students and civil engineers of Great Britain.

In its theoretical discussions the book covers about the same ground as that given in American engineering colleges, but there are few numerical exercises and no problems for solution by the student. That such problems are necessary is, however, recognized by the author in his preface which states that the volume is a lecture room treatment of the subject and should be supplemented by laboratory work and computations. The theory is not given isolated from experience, but methods of testing are explained in an interesting manner, and the principal conclusions of the authorities in all countries are noted. Processes of manufacture which influence strength and ductility also receive some attention. The theory of beams, columns and shafts is presented clearly and concisely, and the subject of stresses in trusses and arches is briefly treated. The author has succeeded admirably in putting much sound doctrine and practical information into a limited space. The notation and terminology leans toward that of the mathematical theory of elasticity, but here and there the author breaks away from that bondage and uses the notation of engineering literature. In short this happy wedlock of theory and practice is one upon which the University of Cambridge should be congratulated. No book has appeared in England in recent years which so fully corresponds to the American ideal of a text-book for sound and successful education. M. M.

GENERAL.

PART V. of the 19th Annual Report, and accompanying Atlas, consists of a collection of papers and reports of the U. S. Geological Survey descriptive of the forests of the West, especially of certain of the forest reserves created by Executive Order of February 22, 1896, prominent among which are the Black Hills, Bighorn, Teton, Yellowstone Park, Priest River, Bitterroot and Washington Forest Reserves. Copies may be secured through United States Senators and Representatives, or by application to the Survey.

THE Liverpool School of Tropical Medicine has just issued a memoir, or small book, containing 'Instructions for the Prevention of Malarial Fever,' for the use of residents in malarious places.

BOOKS RECEIVED.

The Ore Deposits of the United States and Canada. JAMES FURMAN KEMP. New York and London, The Scientific Publishing Co. 1900. Pp. xiv + 481.

Annals of the Astronomical Observatory of Harvard College. EDWARD C. PICKERING, Director. *Visual Observations of the Moon and Planets.* WILLIAM H. PICKERING. Vol. XXXII. Part II. Pp. iv + 117–317. Plates viii–xiv. *Miscellaneous Researches.* Vol. XXXIII. Pp. 287. *Observations made at the Blue Hill Meteorological Observatory.* A. LAWRENCE ROTCH. Pp. 131–280. Cambridge, 1900.

Cyclopedia of American Horticulture. L. H. BAILEY assisted by WILHELM MILLER and many expert Cultivators and Botanists. In 4 volumes. New York, The Macmillan Company. 1900. Vol. I. A.–D. Pp. xxii + 509. $5.00.

SCIENTIFIC JOURNALS AND ARTICLES.

American Chemical Journal, January, 1900. 'On the Molecular Rearrangement of *o*-Aminophenylethyl Carbonate to *o*-Oxyphenylurethane,' by J. H. Ransom. 'Diazocaffeine,' by M. Gomberg. 'The Action of Ethyl Iodide on Tartaric Ester and Sodium Ethylate,' by J. E. Bucher. This number also contains a note on 'Improvements in the Manufacture of Sulphuric Acid.'

February, 1900. 'On Some Abnormal Freezing-point Lowerings produced by Chlorides and Bromides of the Alkaline Earths,' by H. C. Jones and V. J. Chambers. 'The Preparation of Pure Tellurium,' by J. F. Norris, H. Fay and D. W. Edgerly. The authors first prepared pure basic nitrate and then prepared the tellurium from this. 'The Reduction of Selenium Dioxide by Sodium Thiosulphate,' by J. F. Norris and H. Fay. 'Action of Picryl Chloride on Pyrocatechin in Presence of Alkalies,' by H. W. Hillyer. 'Camphoric Acid,' by W. A. Noyes. 'On the Rearrangement of Imido-esters,' by H. L. Wheeler. 'The Double Halides of Antimony with Aniline and the Toluidines,' by H. H. Higbee. 'On the Rancidity of Fats,' by I. Nagel. A note on 'The Wax of the Bacillariaceæ and its Relation to Petroleum.' J. ELLIOTT GILPIN.

The American Naturalist for January is a little late in making its appearance, but its contents may excuse the delay. The first article, by Henry Fairfield Osborn, is a most important contribution to the subject of 'Intercentra and Hypapophyses in the Cervical Region of Mosasaurs, Lizards and Sphenodon,' and is well illustrated. Ales Hrdlicka describes in some detail the 'Arrangement and Preservation of Large Collections of Human Bones for Purposes of Investigation,' and A. D. Mead has an article 'On the Correlation between Growth and Food Supply in Starfish,' in which he shows that starfishes of the same age may vary greatly in size. E. H. Eaton discusses 'The Zoology of the Horn Expedition' to Central Australia, and its bearing on the faunal affinities and geologic changes of Australia, and Henry Fairfield Osborn notes 'A Glacial Pot-Hole in the Hudson River Shales near Catskill, N. Y.' John H. Lovell in 'The Visitors of the Caprifoliaceæ,' describes the structural peculiarities of various genera and species of the honeysuckle family and notes the species of insects which he has observed to visit them, supplementing his notes by the observations of others. There is a large number of reviews, particularly of zoological papers.

THE *Journal of the Boston Society of Medical Science* for January opens with an article by Harold C. Ernst on 'Instruction in Bacteriology in the Medical Schools of America and Europe,' giving an analysis of the replies received from ninety-eight institutions to a circular letter of inquiry. The remainder of the number is devoted to abstracts of papers presented at the meeting of the American Public Health Association, Section of Bacteriology and Chemistry, held October 30, 1899.

SOCIETIES AND ACADEMIES.

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

AT a special meeting of the Science Club of the University of Wisconsin, on the evening of January 24th, Mr. T. C. Chamberlin, of the University of Chicago, addressed the Club on 'Some recent studies of fundamental problems in geology.' Mr. Chamberlin was for five years president of the University of Wisconsin, and a large audience gathered to greet him and to listen to his admirable presentation of an exceedingly difficult subject. By reason of the fact that many of his hearers were not specialists in science, the address was semi-popular, and by special request of the president of the Club, Mr. C. R. Van Hise, it treated particularly of Mr. Chamberlin's well-known studies in this field. These studies have already engaged his attention for a number of years and are not yet completed. Some of the most important conclusions reached by Mr. Chamberlin were given to his audience as he explained 'in confidence to his friends,' as they are not yet in form for publication. The problems discussed—the origin of the solar system, the source of the earth's heat, the earth's physiognomy, its atmosphere, etc., had all been involved in an attempt to frame an adequate working hypothesis to explain the glacial periods.

It was shown that all the hypotheses thus far advanced to explain the glacial periods fail of correspondence with the known facts of geology, particularly the discovery of glacial periods earlier than that of the Quaternary. The kinetic theory of gases applied to the atmospheres of the planets was found to invalidate the La Placian theory of the universe as well as the later theory of meteoric swarms. The atmosphere being the blanket of the earth the explanation of the earth's warm and cold periods was sought in the variation of the amount of carbon dioxide contained, which would materially affect screening or blanketing capacity. Alternate depletion and repletion of the carbon dioxide of the atmosphere might be caused by the variation in the size of land areas and the consequent variation in the carbonation of rocks, and by the separation of carbonates from the littoral portions of the seas. Mr. Chamberlin discussed a theory of the origin of the earth by the slow accretion of solid matter from without, a theory in contrast with that of La Place, in that instead of beginning with an enormously heavy atmosphere, on his theory an atmosphere could not exist until the earth was about one-tenth grown, and would then be extremely attenuated to increase in density with the enlargement of the planet. The exceeding difficulty of securing data for calculation in this field was emphasized, as was the necessity of submitting not one but a number of working hypotheses to the most searching of tests.

Wm. H. Hobbs.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO, MEETINGS OF DECEMBER, 1899.

The session of December 15th was devoted to a paper by Mr. M. F. Guyer on 'Spermatogenesis of Hybrid Pigeons.' "In the spermatogenesis of hybrid pigeons several abnormalities are manifested. These may be classified conveniently under three heads: (1) abnormalities in the structure of the spermatozoa; (2) abnormalities in mitoses; (3) degeneration of the germinal cells. Abnormalities in the spermatozoan structure were present in sterile hybrids, the most noticeable feature being a varicosity or swelling about the middle of the head. In tracing the development of the spermatozoa, this curious modification was found to be due apparently to a lack of development of the head; the nucleus did not elongate completely as in normal spermatogenesis. Abnormalities in mitosis were marked in both fertile and sterile hybrids. Large numbers of multipolar spindles were present. These were usually of the tripolar type. Occasionally two distinct and separate spindles occurred in one cell. The spermatocytes of the first order were the the cells that showed this phenomenon to the greatest extent. In the normal pigeon the chromosomes in the spermatogonia are sixteen in number and in the primary spermatocyte eight. The latter are laid down in rings and each is evidently double. On the spermatogonia of the hybrid there were sixteen chromosomes and in the primary spermatocytes often more than eight. In the latter there may be several of the large double type and a number of smaller rings, or sixteen small ring chromosomes may occur. If sixteen rings were present they were usually located on two separate spindles, eight to each spindle. Another peculiarity in the mitosis was the frequent inequality in the division of the chromosomes, in some instances only about a fourth of a chromosome going to one pole. It is a well known fact that the descendants of hybrids are remarkably variable, hence the possibility that this irregularity in chromatin distribution of the parent germ cell and the variability of the offspring may be connected in some way immediately suggests itself. As for the degeneration of the germ cells, this phenomenon was observed in sterile birds only."

At the meeting of December 20th, Dr. E. S. Riggs, of the Field Columbian Museum, contributed an illustrated lecture, 'The Fossil Mammals of North America.' A large number of lantern slides were exhibited; among them many reproductions in color of the restorations of fossil mammals executed by Mr. Knight.

C. M. Child.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 317th meeting was held on Saturday, January 27th. William Palmer exhibited a series of specimens of the Christmas Fern, *Polystichum acrostichoides*, showing variations in growth due to varying conditions of environment. H. J. Webber showed a portion of one of the negatively geotropic roots of the mangrove, *Rhizophora mangle*, stating that their function, like that of the 'knees' of the cypress was that of aëration, and illustrating his remarks with photographs.

Thomas A. Williams presented some 'Notes on a New Species of *Lecidea* from Mexico,' stating that it was related to *L. speirea* Nyl. It is peculiar on account of its *Lecanora*-like fruit, the apothecia presenting a white border when young and being borne on slight elevations of the thallus, after the manner of the species of Bæomyces with sub-sessile fruits. In some instances gonidia were found in the apothecia, but their occurrence seemed to be accidental rather than normal. The bearing of these structural peculiarities on the systematic relationship of this and other *Lecideas* was discussed.

Barton W. Evermann made 'Some Observations concerning Species and Subspecies', basing his remarks upon the species of darters found in the waters of Lake Maxinkuckee and a new species found in Aubeenaubee Creek, the principal tributary of the lake, but not in the lake itself. This fish is evidently derived from *Etheostoma iowæ*, which is found in the lake, but differs from it clearly and constantly, and no intergrading forms are known. Should, for some reason the lake species and that from the creek invade each other's habitat and interbreed, the result would be the production of individuals possessing characters common to the two species and apparently placing them in the relation of species and subspecies, although if this supposed case were definitely *known* to have occurred, we should regard the individuals as hybrids and the other forms as still distinct species. The speaker reviewed the chief categories of subspecies, concluding that many trinomials were in use where a careful examination of the facts would show that the supposed subspecies are really species. The paper will appear in SCIENCE.

T. W. STANTON,
Secretary.

NEW YORK ACADEMY OF SCIENCE.
SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

THE regular meeting of the Section was held on Monday, January 22d. The first paper of the evening, entitled 'Some Phenomena of Indirect Vision,' was presented by Mr. Clark Wissler. Experiments were made by exposing in the indirect field of vision, while the attention of the observer was fully occupied with objects in the direct field, small letters or numerals. The subjects were not conscious of seeing the characters presented in the indirect field, indeed, one of the subjects whose results were reported did not know until several tests had been made that the characters were there at all. In spite of this failure to receive conscious impressions from the letters and figures, two subjects were found who could by association, and afterwards by memory, give in a large number of cases the correct numeral or letter. These subjects made their associations in the form of visualized images. Many of the errors made were similar to those made in normal vision. Thus, *c* was mistaken for *o*, *35* for *55*, etc. It was held that the experiments suggest a relation between normal phenomena and the abnormal as seen in the hysterical eye, and that they point out a way to more complicated experiments in induced automatic movements.

Professor J. McK. Cattell presented a paper on 'The Relations of Time and Space in Vision.' He described experiments on the perception of moving surfaces, which show that a time series may be perceived as a spacial continuum, and explained that the same phenomena held in the ordinary vision of daily life. Although the eyes, head and body are in continual movement, and the images on the retina are constantly shifting, the field of vision appears to be distinct and stationary. Thus if one glances along a row of books, images follow one another on each retinal element in rapid succession, but these successive and rapid changes result in the perception of a space continuum, all the objects being distinct and arranged side by side.

Professor Buchner read a paper on 'Number Forms.' The paper described with the aid of sketches the fixed visualizations experienced since childhood by a woman 35 years of age.

There are three distinct, uncolored tridimensional forms. The first is half fan-like in shape, lying almost entirely to the left of the mental point of regard, and includes the numbers from 1 to 100. The second includes the names of eight days, from Sunday to Sunday. The third has the names of the twelve months from January to December. The paper pointed out the elements which must appear in any theory of the genesis of the phenomena to which this group belongs.

CHARLES H. JUDD,
Secretary.

CURRENT NOTES ON PHYSIOGRAPHY.

WESTERN NEBRASKA.

A REPORT on the geology and water resources of the westernmost twelfth of Nebraska, by N. H. Darton (19th Ann. Rept. U. S. Geol. Survey, pt. IV., 1899, 721–785, numerous maps and illustrations), presents a very clear picture of an interesting region. The inter-stream areas are generally plateau-like uplands of Tertiary strata, retaining something of their initial smoothness of surface over considerable distances. The sand-hill area of mid-western Nebraska extends west into the broad upland between the North Platte and the Niobrara, where some east-flowing streams are lost. The chief valleys, that of the North Platte being the largest, are cut by streams whose courses seem to be consequent on the general easterly slope given to the region when it was uplifted. Numerous branch streams of unsystematic (insequent) arrangement dissect the valley sides, often producing characteristic bad-lands. The insequent dissection has gone so far between North Platte river and Pumpkinseed creek as to reduce an upland to a narrow ridge with numerous lateral spurs. Pine ridge, trending east and west near the northern border, is the strongest relief in the State; it is a cuesta-like upland whose escarpment is carved into bad-lands by its obsequent streams which descend northward to a denuded area of Cretaceous strata that border the southern flank of the Black hills. The present relation of ground water, springs and streams to a structure and form are well set forth in the later pages of the report. The same author contributes a brief account of the Bad Lands of South Dakota and Nebraska to the September number of the *National Geographic Magazine.*

Mention may be made in this connection of an article by W. D. Matthew on the interpretation of the White river Tertiary strata of Nebraska and South Dakota as an æolian instead of as a lacustrine formation (*Amer. Nat.*, xxxiii., 1899, 403–408).

THE MISSISSIPPI AND MISSOURI RIVERS.

THE annual reports of the commissions on our two greatest rivers (Apps. WW and XX., chief of engineers, United States Army, Washington, 1899) contain a large amount of interesting matter, whose discovery would be much facilitated if the reports were edited with more consideration for their readers. Hundreds of pages without adequate tables of contents and with unchanged page headings make the use of the reports difficult. Numerous measured sections of the Mississippi lead to the conclusion that if the banks are properly revetted to prevent erosion, while levees on the adjacent floodplain restrain the spread of high waters, the channel will be deepened and its capacity to discharge floods increased. The Yazoo basin has 310 miles of levees to protect 7100 square miles of surface. Much money has been spent on the levees by local authorities, and yet it is estimated that the volume of the levees must be increased by more than half in order to bring them up to the proper size. $20,000,000 will be needed to complete the entire levee system; over $2,000,000 having been spent in 1899. The heights of floods, their progress down the river, the locations of levees and areas of overflow are shown on various plates and maps. Besides a new edition of the famous eight-sheet map of the lower Mississippi, a four-sheet map of the upper part of the river was issued during the past year on a scale of 1 : 316,800. No relief is indicated except along the borders of the floodplain, but this suffices to suggest that the valley is the work of a larger river than that now flowing in it; not merely because the valley is wider than the river, but because the curvature of the valley is of a larger pattern than the present river seems capable of producing. The narrow post-glacial rock-walled channel just above Keokuk is well shown in relation to the broader valley up and down stream. Five new sheets of the detailed charts, 1 : 20,000, were issued during the year.

The report on the Missouri announces that it is impracticable to attain permanently useful results in controlling the river at the present rate of expenditure; $317,000 having been spent on river corrections during the year. Along with numerous maps representing various engineering works, the report contains a large number of excellent photographs illustrative of different methods of protecting the river banks, from which an excellent idea of the appearance of the river and of the works undertaken upon it can be gained. A series of detailed charts covering the river from its mouth to Kansas City (400 miles) on a scale of five inches to a mile with five-foot contours, have been drawn but not yet published.

GLACIAL LAKE OUTLETS IN MICHIGAN.

THE 'thumb' of Michigan, enclosing the Saginaw bay branch of Lake Huron on the southeast, is of moderate altitude, yet sufficient to have divided two lobes of the ice sheet of the last glacial epoch, which deposited their interlobate moraines along the axis of the thumb. During the retreat of the ice, the depressions evacuated by these lobes were occupied by lakes; the southeastern by Lake Maumee, overflowing through the outlet past Fort Wayne, long ago described by Gilbert; the northwestern by Lake Saginaw, whose outlet was through the Grand river channel, a magnificent ancient river bed, a mile wide, fifty miles long and sometimes cut over 200 feet deep in the drift. Further retreat of the ice uncovered a point on the crest of the thumb of less altitude than the Fort Wayne outlet; then the southeastern lake drained across the thumb to the northwestern lake, the connecting river carving the Ubly channel, which follows the outer base of an interlobate moraine. The channel is twenty miles long, a mile wide, and from 20 to 100 feet deep. At its southeastern end, its level agrees with that of the shore lines of the lake that it drained; its bed is strewn with bars of gravel and sand, indicating a flow from southeast to northwest; its further end opens upon a delta-like body of gravel at the level of Lake Saginaw. Like the ice-border channels near Syracuse, N. Y., discovered by Gilbert, or those of north Germany recently summarized by Keilhack, the Ubly channel is a geographical feature of marvellous significance in connection with the glacial theory; the interpretation of this excellent example being due to Taylor, in whose admirable series of independent studies it constitutes but one of many items (Ice dams of Lakes Maumee, Whittlesey and Warren, *Amer. Geol.*, xxiv., 1899, 6–38, maps).

CHICAGO AND ITS ENVIRONS.

THE first Bulletin of the Geographic Society of Chicago contains an essay on the 'Geography of Chicago and its Environs' by Salisbury and Alden (pp. 64, 30 figs.). A relief plate as frontispiece shows very clearly the smooth floor of the ancient expanded lake rising towards the rolling uplands through which the lake outlet cut its broad and well-defined channel. The text describes the several physiographic areas, with special reference to the successive stages of the falling lake, of which three are recognized (Glenwood, Calumet, Tolleston). The dunes of the ancient beach ridges that curve around the southern end of Lake Michigan, familiar objects to travelers by rail from the east, are mapped and described.

W. M. DAVIS.

CURRENT NOTES ON METEOROLOGY.

COMPENSATION IN WEATHER.

THE question of seasonal forecasts is considered in the Annual Summary for 1899 of *Climate and Crops: Colorado Section.* The temperature and precipitation data for Denver during the past 28 years have been compiled in order to bring out whatever relation successive seasons bear to one another, in the hope of throwing some light upon the so-called theory of compensation in weather. This theory, stated in a few words, is that a season with an excess or defect of temperature or precipitation is followed by compensating conditions in the succeeding season. The records show that the temperature for a season, or a longer period, furnishes no certain index of the conditions to be expected during the coming season. An exceptionally warm spring or summer following an abnormally cold winter is found to be the exception rather than, as is generally believed, the rule. The conditions with respect to precipitation are much more variable than those connected with the temperature. Notably dry or wet seasons are more likely to be followed by nearly normal ones, than by seasons having compensating, or opposite, characteristics.

In *Nature* for January 25th, MacDowall contributes a further note to this discussion. The subject of this inquiry is the sort of relation subsisting between the cold of a given winter and that of the 30 winters preceding. The cold of the winter seasons is measured by the number of frost days from September to May. The results of the study are as follows: (1) The six mildest winters (since 1871) were each preceded by a 30-year group having more than the average of frost days. (2) The six coldest winters were each preceded by a 30-year group having less than the average of frost days. (3) Of fifteen 30-year groups with excessive cold (*i. e.*, over the average), as many as 12 were followed by mild winters, and only 3 by severe winters.

Studies of the sort here referred to are always interesting, but it must be remembered that the results, so far as they go, relate only to a limited area in each case, and that no definite general conclusions can be reached in this matter without much longer and much more accurate series of observations than we now have.

MONTHLY CLIMATE AND CROP BULLETIN.

The *Climate and Crop Bulletin* of the Weather Bureau for January contains a new feature. This is the addition of a diagram indicating the average daily departure from normal temperature for each day during the month at certain selected Weather Bureau stations east of the Rocky Mountains. These stations are St. Paul, Galveston, Boston, Jacksonville, and Cincinnati. These five cities are believed to represent the general temperature conditions prevailing east of the Rocky Mountains as well as any other like number of stations. Simple graphic representations are always welcome additions in discussions of meteorological phenomena, and this new diagram is certain to meet with approval on the part of all who make use of the *Climate and Crop Bulletin.*

R. DeC. Ward.

Harvard University.

THEODORE POESCHE.

On December 27, 1899, died in Washington, D. C., Theodore Poesche, one of that coterie of scholars of whom Professor Henry said, no one has ever asked me a question that some of them could not answer correctly. Poesche was born at Zoeschen, near Merseburg, graduated at the University of Halle, and was driven to England for participating in the revolution of 1848.

Coming shortly after to America, he published with the coöperation of Carl Copp, a little book entitled 'The New Rome,' in which a comparison is drawn between the hereditary enmity between Rome and Carthage on the one hand and between England and America. In 1857 Poesche came to Washington, where during forty years he served as statistician in the Treasury. In this capacity he was sent in 1872 to advise Bismarck about the working of our internal revenue system. In 1878 appeared his masterpiece, 'Die Arier,' in which the origin of the blonde Aryans, of whom Poesche was a splendid example, is found in the Rökitno marshes of White Russia. The book is a protest against the Asiatic origin of the blondes and contributed no little at the time to change the prevailing opinion. In all his work Mrs. Poesche was the amanuensis of her husband and occupied a prominent place in the Washington literary circle.

O. T. M.

SCIENTIFIC NOTES AND NEWS.

At the meeting of the Royal Geological Society on February 16th, Mr. Henry White, Secretary of the United States Embassy, received on behalf of Mr. G. K. Gilbert, the Wollaston Medal.

Lord Rayleigh, Professor Ramsay, Dr. W. Hittorf and M. Moissan have been elected honorary members of the German Chemical Society.

The polling for the election of a member to represent the University of London in Parliament at last accounts had reached: Sir Michael Foster, 903; Dr. Collins, 662; Mr. Busk, 439.

PROFESSOR MAX VON PETTENKOFER, of Munich, eminent for his contributions to hygiene and sanitation, has been elected a Knight of the Prussian Order Pour le Mérite in the Section of Sciences and Arts.

THE following named medical gentlemen have accepted non-resident membership in the Washington Academy of Sciences: H. P. Bowditch, R. H. Fitz, Boston; A. Jacobi, E. G. Janeway, T. Mitchell Prudden, G. S. Huntington, New York; W. W. Keen, Philadelphia; H. A. Kelley, Wm. Osler, Wm. H. Welch, Wm. S. Halsted, Baltimore; Nicholas Senn, Chicago; P. S. Conner, Cincinnati.

DR. J. B. HATCHER, of Princeton University, whose appointment to the curatorship of paleontology we announced last week, will begin his work at Pittsburg on March 1st.

THE Turin Academy of Sciences has awarded the Bressa Prize of 10,000 lire for the best scientific work published during the past four years to Professor Ernst Haeckel, of Jena.

THE Berlin Academy of Sciences has elected to membership Dr. Wilhelm v. Branco, professor of geology and paleontology in the University.

THE Munich Academy has awarded its great gold medal to the explorer, Eugen Wolf.

THE Academy of Sciences of St. Petersberg has elected Professor Fischer of Berlin, and professor Boltzmann of Vienna, as corresponding members.

THE University of Berlin has conferred an honorary degree of doctor of philosophy on Ignaz Stroof, the chemist at Griesheim.

A BUST of Bernhard von Langenbeck, the eminent surgeon, is to be placed in the great hall of the University of Berlin.

DR. HANS BRUNO GEINITZ, a geologist and paleontologist of distinction, died at Dresden on January 28th in his 86th year.

WE regret also to record, on December 9th, the death of Walter Götze, the botanist, while on an expedition to German East Africa.

THE Highland Agricultural Society has contributed £200 in aid of Professor Ewart's experiments on telegony. A gift of £50 has also been promised by Sir John Gilmour.

A COLLECTION of invertebrate fossils from Tennessee has recently been purchased for the Peabody Museum, Yale University. A rearrangement of many of the specimens in the museum is in progress, and some heretofore inaccessible have been placed on exhibition. The exhibits are to be photographed systematically for an illustrated catalogue.

THE collection of Indian relics which was on exhibition at the Boston Museum for many years, has been presented to the Peabody Museum of Harvard by the heirs of David Kimball. The collection comes from the Algonquins, the Sioux, the Seminoles and the Choctaws, and was made by the famous explorers, Lewis and Clark, about the year 1840.

THE trustees of the Western University of Pennsylvania have decided to begin the erection of the new building of the Allegheny Observatory. It will be erected in River View Park and cost $250,000.

THE St. Petersberg Institute of Experimental Medicine has established a laboratory for the study of plague and for the manufacture of plague serum at Cronstadt. The laboratory is surrounded on all sides by water, so that it can be completely isolated.

THE Brooklyn Institute of Arts and Sciences receives $15,000 by the will of Joseph C. Hoagland.

THE President of the Royal College of Physicians has announced that the annual Harveian Oration would be delivered by Dr. T. Clifford Allbutt, regius professor of physics in the University of Cambridge, that Dr. Archibald Garrod has been appointed Bradshaw Lecturer, and Dr. John Sykes, M.O.H. St. Pancras, Milroy Lecturer for the ensuing year (1901).

THE Washington Academy of Sciences announces that the second of the series of meetings for the exposition of 'Photography as an Aid to Research' will be held at Columbian University at 8 p. m., Thursday, February 15th, when the following topics will be presented: 'Photography as an Aid to the Study of Plants,' by F. V. Coville; 'Photography in the Study of Animal Physiology and Pathology,' by Dr. D. S. Lamb, and 'Photography as an Aid in Medicine and Surgery,' by Dr. W. C. Borden, U. S. A. These will be illustrated by lantern slides. At the succeeding meetings, to be announced later, the following topics will be presented: 'Photography in the Study of Animals; in Geographic Research and Survey; Geology, Paleontology, Astronomy, Physics, Physical and Criminal Anthropology, Ethnology, Archæology, Literature and History.'

The School of Pedagogy, New York University, has announced a special course of lectures on Education, to be given on Monday evenings in March, as follows: March 5th, 'Physical and Mental Growth of Children between the Ages of Six and Twelve Years,' Professor Edward R. Shaw; March 12th, 'Education as a Scientific Pursuit,' Professor Edward Franklin Buchner; March 19th, 'A Fundamental Principle of Mental Development,' Professor Charles H. Judd; March 26th, 'Ethics as determining the End of Education,' Professor Samuel Weir.

The Society of German Men of Science and Physicians will meet at Aachen from the 17th to 21st of September of the present year.

The New York Academy of Sciences will hold its annual meeting on Monday evening, February 26th. The program includes reports of officers for past year: Election of officers, honorary members, corresponding members and fellows; followed by the Presidential Address, by President Henry F. Osborn, entitled 'The Geographical and Faunal Relations of North America, Asia, and Europe during the Tertiary Period.'

The third annual meeting of the National Pure Food and Drug Congress will be held in Washington on March 7th and following days. The meeting is regarded as of special importance as it may increase interest in the National Pure Food and Drug Bill now before Congress.

An International Congress of Ethnographical Science will be held at Paris from the 26th of August to the 1st of September of the present year. There will be seven sections as follows: general ethnology, sociology, psychology religions, linguistics, sciences and arts and descriptive ethnology. The president is M. Maurice Block and the general secretary is M. Georges Raynaud, rue Mouffetard 82, Paris.

The fifth annual mid-winter meeting of the Vermont Botanical Club was held at the University of Vermont, January 26th and 27th. The officers of the club were reëlected: President, Ezra Brainerd; vice-president, C. G. Pringle; secretary and treasurer, L. R. Jones.

A bill has been introduced into the Assembly of the State of New York, providing for a biological station with the objects noted in the last issue of this Journal. The management of the institution is under a board of control, consisting of the New York state fish culturist; the president of the board of the commission of fisheries, game and forest of the state of New York; the president of the New York state fish, game and forest league; the chief of the bureau of nature study of the college of agriculture of Cornell University; and the director of the New York state college of forestry, thus making the board of control to consist of five members. The sum of $10,000 annually is appropriated for the expenses of the station.

An account was quoted from the London *Times* in last week's issue of Science of the work done by Italian students in investigating malaria. Dr. Ronald Ross claims that he was done an injustice, as he had anticipated the Italian investigators in following out the life history of the Hæmamœbidæ (the group of parasites of which the human varieties cause malarial fever) in mosquitoes.

A very valuable machine for cutting minerals, called a *petrotome*, invented by Professor William B. Dwight, of Vassar College, has recently been made accessible for general scientific and commercial uses. Dr. A. E. Foot, of Philadelphia, is to have a large collection of minerals at the Paris Exposition and will exhibit a petrotome in action, to illustrate the best scientific method of cutting rocks and precious stones. Half a dozen large transparent sections have been made by Professor Dwight to be sent to Paris with the machine. One of these is a fossil solidified trunk of a tree. It is seven and a-half inches in diameter and is cut so thin throughout as to show perfectly the microscopic structure of the wood. Another specimen is of a group of Rubelite crystals embedded in Lepidolite, and a third is a section of transparent green serpentine five by two and a-half inches in size. A petrotome has lately been secured by the Geological Commission of Brazil and one by Yale University for their scientific work.

IN spite of the prevalence of typhoid fever in Philadelphia the death rate is lower than usual. The Bureau of Health has given out the following figures for the past twelve years:

	Deaths.	Rate per 1000.
1888	20,372	20.04
1889	20,536	19.74
1890	21,730	20.76
1891	23,367	21.85
1892	24,305	22.25
1893	23,655	21.20
1894	22,680	19.90
1895	23,796	20.44
1896	23,892	20.17
1897	22,735	18.72
1898	23,790	19.18
1899	23,796	18.78

BY a recent decree of the Russian Minister of Education the admission of first-year students by the several medical faculties throughout the empire is restricted to a fixed number. The University of Moscow is limited to 250, Kieff to 200, Charkow to 175, Dorpat to 150, Warsaw to 100, Tomsk to 120, and Kasan to 100. The total number of first-year medical students in Russia must therefore not exceed 1095. This number does not include the students of the St. Petersberg Medico-Military Academy, which may admit 250 first-year students.

ACCORDING to the *Publishers' Weekly*, there were last year published in the United States 176 books in the sciences as compared with 143 in 1898. These numbers do not, however, include educational or medical books, or books in the 'useful arts.'

AT a special meeting of the London Chemical Society of London, Professor T. E. Thorp, F.R.S., gave a memorial lecture in honor of Victor Meyer. He said, according to the report in the London *Times*, that as a friend of nearly 30 years' standing, and as one who studied with him under Bunsen, he had acceded to the request of the council to record its appreciation of the remarkable services rendered by Meyer to the science he cultivated with such assiduity and success. After an account of Meyer in his student days at Heidelberg and of his work as one of Bunsen's assistants, the lecturer told how in 1868 he entered Baeyer's laboratory in Berlin, where his success as a private teacher procured him the position of assistant to Fehling at the Stuttgart Polytechnic. There he made one or two important discoveries, but in less than a year he was called, when barely 24 years of age, to succeed Wislicenus at Zürich. His 13 years' stay there constituted the most fruitful and brilliant period of his career, and before its close he had brought himself within the foremost rank of contemporary investigators. Some idea of his power of work and of the stimulus he gave to others might be gleaned from the fact that during that period the Zürich Laboratory gave close on 130 papers and memoirs to chemical literature. It was at Zürich, too, that he devised his various methods of determining vapor densities and carried out some of his work on the dissociation of the halogens. Pyrochemical problems always interested him, and he expressed the belief that a new chemistry with new and undreamt-of discoveries would disclose itself when vessels were obtained capable of bearing temperatures at which meter could no longer exist and oxyhydrogen gas became an uninflammable mixture. In 1882, when continuing a series of University lectures on benzene derivations which had been interrupted by his friend Weith's death, he made what was, perhaps, his most brilliant discovery, that of thiophen, and within about six months of his first observation he was in a position to show by actual preparations that its chemistry was hardly less extensive than that of benzene itself. On the death of Hübner he was called to Göttingen, and in 1888 to Heidelberg, as successor to Bunsen, with the coveted title of Geheimrath and the promise of a new and enlarged laboratory. In conjunction with a number of his pupils he there began the investigation of the conditions determining both the gradual and explosive combustion of gaseous mixtures, and in 1892 with Wachter he announced the existence of the iodoso-compounds, the study of which led to the discovery of the remarkable substances known as the iodonium bases. The formation and electrolysis of ethereal salts of aromatic acids occupied him from 1894 up to the year of his death, which took place at the age of 49 on August 8, 1897. To the literature of chemistry, either alone or in conjunction with his pupils, he contributed over 300 memoirs and papers. As the director of a large chemical laboratory and as a laboratory teacher he worthily followed in the footsteps of Bunsen. He was an admirable lecturer, clear and vigorous, while as a teacher he had a wonderful power of infusing enthusiasm into his students. His literary ability, combined with his faculty of exposition, made him an admirable writer of popular science articles.

UNIVERSITY AND EDUCATIONAL NEWS.

Mrs. Thomas McKean has given $250,000 to the University of Pennsylvania towards the cost of the new Law School building.

Boston University receives $50,000 by the will of O. H. Durrell, of East Cambridge, Mass.

A half million dollars will be distributed by Dr. D. K. Pearsons of Chicago, beginning March 1st, among fourteen colleges throughout the United States. Most of the donations are made on condition that the colleges raise a certain amount, generally $50,000, or an amount equal to the gift, within a given time. The first college to claim its proportion of the $500-000 is Mount Holyoke College, South Hadley. This college receives $50,000, and the gift will be made March 1st. Some of the other colleges to become beneficiaries of Dr. Pearson's philanthropy are Yankton College, South Dakota; Berea College, Berea, Ky.; Colorado College, Colorado Springs, Col., and McKenzie College Lebanon, Ill., which will receive $50,000. Each has received a former gift from Dr. Pearsons. Dr. Pearsons has already given $2,500,-000 to the cause of education.

The Baltimore Association for the Promotion of the University Education of Women is prepared to offer a foreign fellowship of the value of $500 for the year 1900–1901. Preference will be given in the award of this fellowship to women from Maryland, or women who have identified themselves with educational interests in Maryland.

A school of forestry will be established at Yale University under the Sheffield Scientific School. It will occupy the house left to the University by the late Professor Marsh.

The proposed changes in the examinations for the Mathematical Tripos at Cambridge, abolishing the order of Merit and the Senior Wrangler, have been defeated in the Senate by a vote of 152–139.

Plans are being made for the establishment of a school for scientific instruction and practical training in agriculture and horticulture, to be situated at Chappaqua, 33 miles from New York city. The students would attend lectures and do work in the New York Botanical Garden, which is easily accessible.

It is reported in the daily papers that Mr. Alexis E. Frye, superintendent of schools in Cuba, is arranging for a number of Cuban teachers to attend the Harvard summer school.

It is announced that Rear Admiral William Sampson has been offered and has declined the presidency of the Massachusetts Institute of Technology.

Dr. Samuel J. Barnett, professor of physics in Colorado College, has been appointed assistant professor of physics in the Leland Stanford, Jr. University.

Dr. Edward Lewis Stevens, B.A. (La. State University), Ph.D. (New York University), has been appointed president of the newly established Louisiana State Industrial School.

Dr. W. Wien, professor of physics at the University of Giesen, has been called to Würzberg, and Dr. Ludwig Knor of Jena, has been called to the professorship in chemistry in the University of Freiburg, i. B. Dr. Winkler has been made assistant professor of agriculture in the Agricultural Station at Vienna, and Dr. F. R. Kjellmann, professor of botany in the University of Upsala. Dr. Ebermeyer, professor of agriculture and meteorology at Munich, has retired.

SCIENCE

Friday, March 2, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*PSYCHOLOGY AND SOCIAL PRACTICE.**

In coming before you I had hoped to deal with the problem of the relation of psychology to the social sciences—and through them to social practice, to life itself. Naturally, in anticipation, I had conceived a systematic exposition of fundamental principles covering the whole ground, and giving every factor its due rating and position. That discussion is not ready to-day. I am loath, however, completely to withdraw from the subject, especially as there happens to be a certain phase of it with which I have been more or less practically occupied within the last few years. I have in mind the relation of Psychology to Education. Since education is primarily a social affair, and since educational science is first of all a social science, we have here a section of the whole field. In some respects there may be an advantage in approaching the more comprehensive question through the medium of one of its special cases. The absence of elaborated and coherent views may be made up for by a background of experience, which shall check the projective power of reflective abstraction, and secure a translation of large words and ideas into specific images. This special territory, moreover, may be such as to afford both sign-posts and broad avenues to the larger

* Address of the President of the American Psychological Association, New Haven meeting, December, 1899.

sphere—the place of psychology among the social sciences. Because I anticipate such an outcome, and because I shall make a survey of the broad field from the special standpoint taken, I make no apology for presenting this discussion to an Association of Psychologists rather than to a gathering of educators.

In dealing with this particular question, it is impossible not to have in mind the brilliant and effective discourses recently published by my predecessor in this chair. I shall accordingly make free to refer to points, and at times to words, in his treatment of the matter. Yet, as perhaps I hardly need say, it is a problem of the most fundamental importance for both psychology and social theory that I wish to discuss, not any particular book or article. Indeed with much of what Dr. Münsterberg says about the uselessness and the danger for the teacher of miscellaneous scraps of child study, of unorganized information regarding the nervous system, and of crude and uninterpreted results of laboratory experiment, I am in full agreement. It is doubtless necessary to protest against a hasty and violent bolting of psychological facts and principles which, of necessity, destroys their scientific form. It is necessary to point out the need of a preliminary working over of psychological material adapting it to the needs of education. But these are minor points. The main point is whether the standpoint of psychological science, as a study of mechanism, is indifferent and opposed to the demands of education with its free interplay of personalities in their vital attitudes and aims.

I.

The school practice of to-day has a definite psychological basis. Teachers are already possessed by specific psychological assumptions which control their theory and their practice. The greatest obstacle to the introduction of certain educational reforms is precisely the permeating persistence of the underlying psychological creed. Traced back to its psychological ultimates, there are two controlling bases of existing methods of instruction. One is the assumption of a fundamental distinction between child psychology and the adult psychology where, in reality, identity reigns; viz.: in the region of the motives and conditions which make for mental power. The other is the assumption of likeness where marked difference is the feature most significant for educational purposes; I mean the specialization of aims and habits in the adult, compared with the absence of specialization in the child, and the connection of undifferentiated status with the full and free growth of the child.

The adult is primarily a person with a certain calling and position in life. These devolve upon him certain specific responsibilities which he has to meet, and call into play certain formed habits. The child is primarily one whose calling is growth. He is concerned with arriving at specific ends and purposes—instead of having a general framework already developed. He is engaged in forming habits rather than in definitely utilizing those already formed. Consequently he is absorbed in getting that all around contact with persons and things, that range of acquaintance with the physical and ideal factors of life, which shall afford the background and material for the specialized aims and pursuits of later life. He is, or should be, busy in the formation of a flexible variety of habits whose sole immediate criterion is their relation to full growth, rather than in acquiring certain skills whose value is measured by their reference to specialized technical accomplishments. This is the radical psychological and biological distinction, I take it, between the child and the adult. It is because of this distinction that children are neither physiologically nor mentally describable as 'little men and women.'

The full recognition of this distinction means of course the selection and arrangement of all school materials and methods for the facilitation of full normal growth, trusting to the result in growth to provide the instrumentalities of later specialized adaptation. If education means the period of prolonged infancy, it means nothing less than this. But look at our school system and ask whether the 3 R's are taught, either as to subject matter or as to method, with reference to growth, to its present demands and opportunities; or as technical acquisitions which are to be needed in the specialized life of the adult. Ask the same questions about geography, grammar and history. The gap between psychological theory and the existing school practice becomes painfully apparent. We readily realize the extent to which the present school system is dominated by carrying over into child life a standpoint and method which are significant in the psychology of the adult.

The narrow scope of the traditional elementary curriculum, the premature and excessive use of logical analytic methods, the assumption of ready-made faculties of observation, memory, attention, etc., which can be brought into play if only the child chooses to do so, the ideal of formal discipline—all these find a large measure of their explanation in neglect of just this psychological distinction between the child and the adult. The hold of these affairs upon the school is so fixed that it is impossible to shake it in any fundamental way, excepting by a thorough appreciation of the actual psychology of the case. This appreciation cannot be confined to the educational leaders and theorists. No individual instructor can be sincere and whole hearted, to say nothing of intelligent, in carrying into effect the needed reforms, save as he genuinely understands the scientific basis and necessity of the change.

But in another direction there is the assumption of a fundamental difference: Namely, as to the conditions which secure intellectual and moral progress and power.* No one seriously questions that, with an adult, power and control are obtained through realization of personal ends and problems, through personal selection of means and materials which are relevant, and through personal adaptation and application of what is thus selected, together with whatever of experimentation and of testing is involved in this effort. Practically every one of these three conditions of increase in power for the adult is denied for the child. For him problems and aims are determined by another mind. For him the material that is relevant and irrelevant is selected in advance by another mind. And, upon the whole, there is such an attempt to teach him a ready-made method for applying his material to the solution of his problems, or the reaching of his ends that the factor of experimentation is reduced to the minimum. With the adult we unquestioningly assume that an attitude of personal inquiry, based upon the possession of a problem which interests and absorbs, is a necessary precondition of mental growth. With the child we assume that the precondition is rather the willing disposition which makes him ready to submit to any problem and material presented from without. Alertness is our ideal in one case; docility in the other. With one, we assume that power of attention develops in dealing with problems which make a personal appeal, and through personal responsibility for determining what is relevant. With the other we provide next to no opportunities for the evolution of problems out of immediate experience, and allow next to no free mental play for selecting, assorting and adapting the ex-

*I owe this point specifically (as well as others more generally) to my friend and colleague, Mrs. Ella Flagg Young.

periences and ideas that make for their solution. How profound a revolution in the position and service of text-book and teacher, and in methods of instruction depending therefrom, would be effected by a sincere recognition of the psychological identity of child and adult in these respects can with difficulty be realized.

Here again it is not enough that the educational commanders should be aware of the correct educational psychology. The rank and file, just because they are persons dealing with persons, must have a sufficient grounding in the psychology of the matter to realize the necessity and the significance of what they are doing. Any reform instituted without such conviction on the part of those who have to carry it into effect would never be undertaken in good faith, nor in the spirit which its ideal inevitably demands; consequently it could lead only to disaster.

At this point, however, the issue defines itself, somewhat more narrowly. It may be true, it is true, we are told, that some should take hold of psychological methods and conclusions, and organize them with reference to the assistance which they may give to the cause of education. But this is not the work of the teacher. It belongs to the general educational theorist—the middleman between the psychologist and the educational practitioner. He should put the matter into such shape that the teacher may take the net results in the form of advice and rules for action; but the teacher who comes in contact with the living personalities must not assume the psychological attitude. If he does he reduces persons to objects, and thereby distorts, or rather destroys, the ethical relationship which is the vital nerve of instruction (*Psychology and Life*, p. 122, and pp. 136–138).

That there is some legitimate division of labor between the general educational theorist and the actual instructor, there is of course no doubt. As a rule, it will not be the one actively employed in instruction who will be most conscious of the psychological basis and equivalents of the educational work, nor most occupied in finding the pedagogical rendering of psychological facts and principles. Of necessity, the stress of interest will be elsewhere. But we have already found reason for questioning the possibility of making the somewhat different direction of interest into a rigid dualism of a legislative class on one side and an obedient subject class on the other. Can the teacher ever receive 'obligatory prescriptions'? Can he receive from another a statement of the means by which he is to reach his ends, and not become hopelessly servile in his attitude? Would not such a result be even worse than the existing mixture of empiricism and inspiration?—just because it would forever fossilize the empirical element and dispel the inspiration which now quickens routine. Can a passive, receptive attitude on the part of the instructor (suggesting the soldier awaiting orders from a commanding general) be avoided, unless the teacher, as a student of psychology, himself sees the reasons and import of the suggestions and rules that are proffered him?

I quote a passage that seems of significance: "Do we not lay a special linking science everywhere else between the theory and practical work? We have engineering between physics and the practical workingmen in the mills; we have a scientific medicine between the natural science and the physician" (p. 138). The sentences suggest in an almost startling way, that the real essence of the problem is found in an *organic* connection between the two extreme terms—between the theorist and the practical worker—through the medium of the linking science. The decisive matter is the extent to which the ideas of the theorist actually project themselves, through the kind offices of the middle man, into the consciousness of the practitioner. It is the participation by the practical man in the theory, through the agency of the linking science, that determines at once the effectiveness of the work done, and the moral freedom and personal development of the one engaged in it. It is because the physician no longer follows rules, which, however rational in themselves, are yet arbitrary to him (because grounded in principles that he does not understand), that his work is becoming liberal, attaining the dignity of a profession, instead of remaining a mixture of empiricism and quackery. It is because, alas, engineering makes only a formal and not a real connection between physics and the practical workingmen in the mills, that our industrial problem is an ethical problem of the most serious kind. The question of the amount of wages the laborer receives, of the purchasing value of this wage, of the hours and conditions of labor, are, after all, secondary. The problem primarily roots in the fact that the mediating science does not connect with his consciousness, but merely with his outward actions. He does not appreciate the significance and bearing of what he does; and he does not perform his work because of sharing in a larger scientific and social consciousness. If he did, he would be free. All other proper accompaniments of wage, and hours, healthful and inspiring conditions would be added unto him, because he would have entered into the ethical kingdom. Shall we seek analogy with the teacher's calling in the workingmen in the mill, or in the scientific physician?

It is quite likely that I shall be reminded that I am overlooking an essential difference. The physician, it will be said, is dealing with a body which either is in itself a pure object, a causal interplay of anatomical elements, or is something which lends itself naturally and without essential loss to treatment from this point of view; while the case is quite different in the material with which the teacher deals. Here is personality, which is destroyed when regarded as an object. But the gap is not so pronounced nor so serious as this objection implies. The physician after all is not dealing with a lifeless body; with a simple anatomical structure, or interplay of mechanical elements. Life functions, active operations, are the reality which confront him. We do not have to go back many centuries in the history of medicine to find a time when the physician attempted to deal with these functions directly and immediately. They were so overpoweringly present, they forced themselves upon him so obviously and so constantly that he had no resource save a mixture of magic and empiricism: magic, so far as he followed methods derived from uncritical analogy, or from purely general speculation on the universe and life; empiricism, so long as he just followed procedures which had been found helpful before in cases which somewhat resembled the present. We have only to trace the intervening history of medicine to appreciate that it is precisely the ability to state function in terms of structure, to reduce life in its active operations to terms of a causal mechanism, which has taken the medical calling out of this dependence upon a vibration between superstition and routine. Progress has come by taking what is really an activity as if it were only an object. It is the capacity to effect this transformation of life activity which measures both the scientific character of the physician's procedure and his practical control, the certainty and efficacy of what he, as a living man, does in relation to some other living man.

It is an old story, however, that we must not content ourselves with analogies. We must find some specific reason in the principles of the teacher's own activities for believing that psychology—the ability to transform a living personality into an objective mechanism for the time being—is not merely an incidental help, but an organic necessity. Upon the whole, the best efforts of teachers at present are partly paralyzed, partly distorted, and partly rendered futile precisely from the fact that they are in such immediate contact with sheer, unanalyzed personality. The relation is such a purely ethical and personal one that the teacher cannot get enough outside the situation to handle it intelligently and effectively. He is in precisely the condition in which the physician was when he had no recourse save to deal with health as entity or force on one side, and disease as opposing agency or invading influence upon the other. The teacher reacts *en bloc*, in a gross wholesale way, to something which he takes in an equally undefined and total way in the child. It is the inability to regard, upon occasion, both himself and the child as just objects working upon each other in specific ways that compels him to resort to purely arbitrary measures, to fall back upon mere routine traditions of school teaching, or to fly to the latest fad of pedagogical theorists—the latest panacea peddled out in school journals or teachers' institutes—just as the old physician relied upon his magic formula.

I repeat, it is the fundamental weakness of our teaching force to-day (putting aside teachers who are actually incompetent by reason either of wrong motives or inadequate preparation), that they react in gross to the child's exhibitions in gross without analyzing them into their detailed and constituent elements. If the child is angry, he is dealt with simply as an angry being; anger is an entity, a force, not a symptom. If a child is inattentive, this again is treated as a mere case of refusal to use the faculty or function of attention, of sheer unwillingness to act. Teachers tell you that a child is careless or inattentive in the same final way in which they would tell you that a piece of paper is white. It is just a fact, and that is all there is of it. Now it is only through some recognition of attention as a mechanism, some awareness of the interplay of sensations, images and motor impulses which constitute it as an objective fact that the teacher can deal effectively with attention as a function. And, of course, the same is true of memory, quick and useful observation, good judgment and all the other practical powers the teacher is attempting to cultivate.

Consideration of the abstract concepts of mechanism and personality is important. Too much preoccupation with them in a general fashion, however, without translation into relevant imagery of actual conditions is likely to give rise to unreal difficulties. The ethical personality does not go to school naked, it takes with it the body as the instrument through which all influences reach it, and through control of which its ideas are both elaborated and expressed. The teacher does not deal with personality at large, but as expressed in intellectual and practical impulses and habits. The ethical personality is not formed—it is forming. The teacher must provide stimuli leading to the equipment of personality with active habits and interests. When we consider the problem of forming habits and interests we find ourselves at once confronted with matters of this sort: What stimuli shall be presented to the sense organs and how? What stable complexes of associations shall be organized? What motor impulses shall be evoked, and to what extent? How shall they be induced in such a way as to bring favorable stimuli under greater control, and to lessen the danger of excitation from undesirable stimuli? In a word, the teacher is dealing with the psychical factors that are concerned with furtherance of certain habits, and the inhibition of others—habits intellectual, habits emotional, habits in overt action.

Moreover, all the instruments and materials with which the teacher deals must be considered as psychical stimuli. Such consideration involves of necessity, a knowledge of their reciprocal reactions—of what goes by the name of causal mechanism. The introduction of certain changes into a net-work of associations, the reinforcement of certain sensori-motor connections, the weakening or displacing of others—this is the psychological rendering of the greater part of the teacher's actual business. It is not that one teacher employs mechanical considerations, and that the other does not, appealing to higher ends; it is that one does not know his mechanism, and consequently acts servilely, superstitiously and blindly, while the other, knowing what he is about, acts freely, clearly and effectively.*

The same thing is true on the side of materials of instruction—the school studies. No amount of exaltation of teleological personality (however true, and however necessary the emphasis), can disguise from us the fact that instruction is an affair of bringing a child into intimate relations with concrete objects, positive facts, definite ideas and specific symbols. The symbols are objective things in arithmetic, reading and writing. The ideas are truths of history and of science. The facts are derived from such specific disciplines as geography and language, botany and astronomy. To suppose that by some influence of pure personality upon pure personality, conjoined with a knowledge of rules formulated by an educational theorist, an effective interplay of this body of physical and ideal objects with the life of the child can be effective, is, I submit, nothing but an appeal to magic, plus dependence upon servile routine. Symbols in reading and writing and number, are both in themselves, and in the way in which they stand for ideas, elements in a mechanism which has to be rendered operative within the child. To bring about this influence in the most helpful and economical way, in the most fruitful and liberating way, is absolutely impossible save as the teacher has some power to transmute symbols and contents into their working psychical equivalents: and save as he also has the power to see what it is in the child, as a psychical mechanism, that affords maximum leverage.

* That some teachers get their psychology by instinct more effectively than others by any amount of reflective study may be unreservedly stated. It is not a question of manufacturing teachers, but of reinforcing and enlightening those who have a right to teach.

Probably I shall now hear that at present the danger is not of dealing with acts and persons in a gross, arbitrary way, but (so far as what is called new education is concerned) in treating the children too much as mechanism, and consequently seeking for all kinds of stimuli to stir and attract—that, in a word, the tendency to reduce instruction to a merely agreeable thing, weakening the child's personality and indulging his mere love of excitement and pleasure, is precisely the result of taking the psycho-mechanical point of view. I welcome the objection for it serves to clear up the precise point. It is through a partial and defective psychology that the teacher, in his reaction from dead routine and arbitrary moral and intellectual discipline, has substituted an appeal to the satisfaction of momentary impulse. It is not because the teacher has a knowledge of the psycho-physical mechanism, but because he has a partial knowledge of it. He has come to consciousness of certain sensations, and certain impulses, and of the ways in which these may be stimulated and directed, but he is in ignorance of the larger mechanism (just as a mechanism), and of the causal relations which subsist between the unknown part and the elements upon which he is playing. What is needed to correct his errors is not to inform him that he gets only misleading from taking the psychical point of view; but to reveal to him the scope and intricate interactions of the mechanism as a whole. Then he will realize that while he is gaining apparent efficacy in some superficial part of the mechanism, he is disarranging, dislocating and disintegrating much more fundamental factors in it. In a word he is operating not as a psychologist, but as a poor psychologist, and the only cure for a partial psychology is a fuller one. He is gaining the momentary attention of the child through an appeal to pleasant color, or exciting tone, or agreeable association, but at the expense of isolating one cog and ratchet in the machinery, and making it operate independently of the rest. In theory, it is as possible to demonstrate this to a teacher, showing how the faulty method reacts unhappily into the personality, as it is to locate the points of wrong construction, and of ineffective transfer of energy in a physical apparatus.

This suggests the admission made by writers in many respects as far apart as Dr. Harris and Dr. Münsterberg—that scientific psychology is of use on the pathological side—where questions of 'physical and mental health' are concerned. But is there anything with which the teacher has concern that is not included in the ideal of physical and mental health? Does health define to us anything less than the teacher's whole end and aim? Where does pathology leave off in the scale and series of vicious aims and defective means? I see no line between the more obvious methods and materials which result in nervous irritation and fatigue; in weakening the power of vision, in establishing spinal curvatures; and others which, in more remote and subtle, but equally real ways, leave the child with, say, a muscular system which is only partially at the service of his ideas, with blocked and inert brain paths between eye and ear, and with a partial and disconnected development of the cerebral paths of visual imagery. What error in instruction is there which could not, with proper psychological theory, be stated in just such terms as these? A wrong method of teaching reading, wrong I mean in the full educational and ethical sense, is also a case of pathological use of the psycho-physical mechanism. A method is ethically defective that, while giving the child a glibness in the mechanical facility of reading, leaves him at the mercy of suggestion and chance environment to decide whether he reads the 'yellow journal,' the trashy novel, or the literture which inspires and makes more valid his whole life. Is it any less certain that this failure on the ethical side is repeated in some lack of adequate growth and connection in the psychical and physiological factors involved? If a knowledge of psychology is important to the teacher in the grosser and more overt cases of mental pathology is it not even more important in these hidden and indirect matters—just because they are less evident and more circuitous in their operation and manifestation?

The argument may be summarized by saying that there is controversy neither as to the ethical character of education, nor as to the abstraction which psychology performs in reducing personality to an object. The teacher is, indeed, a person occupied with other persons. He lives in a social sphere—he is a member and an organ of a social life. His aims are social aims; the development of individuals taking ever more responsible positions in a circle of social activities continually increasing in radius and complexity. Whatever he as a teacher effectively does, he does as a person; and he does with and towards persons. His methods, like his aims, when actively in operation, are practical, are social, are ethical, are anything you please —save merely psychical. In comparison with this, the material and the data, the standpoint and the methods of psychology, are abstract. They transform specific acts and relations of individuals into a flow of processes in consciousness; and these processes can be adequately identified and related only through reference to a biological organism. I do not think there is danger of going too far in asserting the social and teleological nature of the work of the teacher; or in asserting the abstract and partial character of the mechanism into which the psychologist, as a psychologist, transmutes the play of vital values.

Does it follow from this that any attempt on the part of the teacher to perform this abstraction, to see the pupil as a mechanism, to define his own relations and that of the study taught in terms of causal influences acting upon this mechanism, are useless and harmful? On the face of it, I cannot understand the logic which says that because mechanism is mechanism, and because acts, aims, values are vital, therefore a statement in terms of one is alien to the comprehension and proper management of the other. Ends are not compromised when referred to the means necessary to realize them. Values do not cease to be values when they are minutely and accurately measured. Acts are not destroyed when their operative machinery is made manifest. The statement of the disparity of mechanism and actual life, be it never so true, solves no problem. It is no distinction that may be used off-hand to decide the question of the relation of psychology to any form of practice. It is a valuable and necessary distinction; but it is only preliminary. The purport of our discussion has, indeed, led us strongly to suspect any ideal which exists purely at large, out of relation to machinery of execution, and equally a machinery that operates in no particular direction.

The proposition that a description and explanation of stones, iron and mortar, as an absolutely necessary causal nexus of mechanical conditions, makes the results of physical science unavailable for purposes of practical life, would hardly receive attention to-day. Every sky-scraper, every railway bridge is a refutation, compared with which oceans of talk are futile. One would not find it easy to stir up a problem even if he went on to include, in this same mechanical system, the steam derricks that hoist the stones and iron, and the muscles and nerves of architect, mason and steel worker. The simple fact is still too obvious; the more thorough-going and complete the mechanical and causal statement, the more controlled, the more economical is the discovery and realization of human aims. It is not in spite of nor in neglect of, but because of the mechanical statement that human activity has been freed, and made effective in thousands of new practical directions, upon a scale and with a certainty hitherto undreamed of. Our discussion tends to suggest that we entertain a similar question regarding psychology only because we have as yet made so little headway—just because there is so little scientific control of our practice in these directions; that at bottom our difficulty is local and circumstantial, not intrinsic and doctrinal. If our teachers were trained as architects are trained, if our schools were actually managed on a psychological basis as great factories are run on the basis of chemical and physical science; if our psychology were sufficiently organized and coherent to give as adequate a mechanical statement of human nature as physics does of its material, we should never dream of discussing this question.

I cannot pass on from this phase of the discussion without at least incidental remark of the obverse side of the situation. The difficulties of psychological observation and interpretation are great enough in any case. We cannot afford to neglect any possible auxiliary. The great advantage of the psychological laboratory is paid for by certain obvious defects. The completer control of conditions, with resulting greater accuracy of determination, demands an isolation, a ruling out of the usual media of thought and action, which leads to a certain remoteness, and easily to a certain artificiality. When the result of laboratory experiment informs us, for example, that repetition is the chief factor influencing recall, we must bear in mind that the result is obtained with nonsense material—*i. e.*, by excluding the conditions of ordinary memory. The result is pertinent if we state it thus: The more we exclude the usual environmental adaptations of memory the greater importance attaches to sheer repetition. It is dubious (and probably perverse) if we say: Repetition is the prime influence in memory.

Now this illustrates a general principle. Unless our laboratory results are to give us artificialities, mere scientific curiosities, they must be subjected to interpretation by gradual reapproximation to conditions of life. The results may be very accurate, very definitive in form; but the task of reviewing them so as to see their actual import is clearly one of great delicacy and liability to error. The laboratory, in a word, affords no final refuge that enables us to avoid the ordinary scientific difficulties of forming hypotheses, interpreting results, etc. In some sense (from the very accuracy and limitations of its results) it adds to our responsibilities in this direction. Now the school, for psychological purposes, stands in many respects midway between the extreme simplifications of the laboratory and the confused complexities of ordinary life. Its conditions are those of life at large; they are social and practical. But it approaches the laboratory in so far as the ends aimed at are reduced in number, are definite, and thus simplify the conditions; and their psychological phase is uppermost—the formation of habits of attention, observation, memory, etc.—while in ordinary life these are secondary and swallowed up.

If the biological and evolutionary attitude is right in looking at mind as fundamentally an instrument of adaptation, there are certainly advantages in any mode of approach which brings us near to its various adaptations while they are still forming, and under conditions selected with special reference to promoting these adaptations (or faculties). And this is precisely the situation we should have in a properly organized system of education. While the psychological theory would guide and illuminate the practice, acting upon the theory would immediately test it, and thus criticise it, bringing about its revision and growth. In the large and open sense of the words psychology becomes a working hypothesis, instruction is the experimental test and demonstration of the hypothesis; the result is both greater practical control and continued growth in theory.

II.

I must remind myself that my purpose does not conclude with a statement of the auxiliary relation of psychology to education; but that we are concerned with this as a type case of a wider problem—the relation of psychology to social practice in general. So far I have tried to show that it is not in spite of its statement of personal aims and social relations in terms of mechanism that psychology is useful, but because of this transformation and abstraction. Through reduction of ethical relations to presented objects, we are enabled to get outside of the existing situation; to see it objectively, not merely in relation to our traditional habits, vague aspirations and capricious desires. We are able to see clearly the factors which shape it, and therefore to get an idea of how it may be modified. The assumption of an identical relationship of physics and psychology to practical life is justified. Our freedom of action comes through its statement in terms of necessity. By this translation our control is enlarged, our powers are directed, our energy conserved, our aims illuminated.

The school is an especially favorable place in which to study the availability of psychology for social practice, because in the school the formation of a certain type of social personality, with a certain attitude and equipment of working powers, is the express aim. In idea at least no other purpose restricts or compromises the dominance of the single purpose. Such is not the case in business, politics and the professions. All these have upon their surface, taken directly, other ends to serve. In many instances these other aims are of far greater immediate importance; the ethical result is subordinate or even incidental. Yet as it profiteth a man nothing to gain the whole world and lose his own self, so indirectly and ultimately all these other social institutions must be judged by the contribution which they make to the value of human life. Other ends may be immediately uppermost, but these ends must in turn be means; they must subserve the interests of conscious life or else stand condemned.

In other words, the moment we apply an ethical standard to the consideration of social institutions, that moment they stand on exactly the same level as does the school, viz.: as organs for the increase in depth and area of the realized values of life. In both cases the statement of the mechanism, through which the ethical ends are realized, is not only permissible, but absolutely required. It is not merely incidentally, as a grateful addition to its normal task, that psychology serves us. The essential nature of the standpoint which calls it into existence, and of abstraction which it performs, is to put in our possession the method by which values are introduced and effected in life. The statement of personality as an object; of social relations as a mechanism of stimuli and inhibitions, is precisely the statement of ends in terms of the method of their realization.

It is remarkable that men are so blind to the futility of a morality which merely blazons ideals, erects standards, asserts law without finding in them any organic provision for their own realization. For ideals are held up to follow; standards are given to work by; laws are provided to guide action. The sole and only reason for their conscious moral statement is, in a word, that they may influence and direct conduct. If they cannot do this, not merely by accident, but of their own intrinsic nature, they are worse than inert. They are impudent impostors and logical self-contradictions.

When men derive their moral ideas and laws from custom, they also realize them through custom; but when they are in any way divorced from habit and tradition, when they are consciously proclaimed, there must be some substitute for custom as an organ of execution. We must know the method of their operation and know it in detail. Otherwise the more earnestly we insist upon our categorial imperatives, and upon their supreme right of control, the more flagrantly helpless we are as to their actual domination. The fact that conscious, as distinct from customary, morality and psychology have had a historic parallel march, is just the concrete recognition of the necessary equivalence between ends consciously conceived, and interest in the means upon which the ends depend. We have the same reality stated twice over: once as value to be realized, and once as mechanism of realization. So long as custom reigns, as tradition prevails, so long as social values are determined by instinct and habit, there is no conscious question as to the method of their achievement, and hence no need of psychology. Social institutions work of their own inertia, they take the individual up into themselves and carry him along in their own sweep. The individual is dominated by the mass life of his group. Institutions and the customs attaching to them take care of society both as to its ideals and its methods. But when once the values come to consciousness, when once a Socrates insists upon the organic relation of a reflective life and morality, then the means, the machinery by which ethical ideas are projected and manifested, comes to consciousness also. Psychology must needs be born as soon as morality becomes reflective.

Moreover, psychology, as an account of the mechanism of workings of personality, is the only alternative to an arbitrary and class view of society, to an aristocratic view in the sense of restricting the realization of the full worth of life to a section of society. The growth of a psychology that, as applied to history and sociology, tries to state the interactions of groups of men in familiar psychical categories of stimulus and inhibition, is evidence that we are ceasing to take existing social forms as final and unquestioned. The application of psychology to social institutions is the only scientific way of dealing with their ethical values in their present unequal distribution, their haphazard execution and their thwarted development. It marks just the recognition of the principle of sufficient reason in the large matters of social life. It is the recognition that the existing order is determined neither by fate nor by chance, but is based on law and order, on a system of existing stimuli and modes of reaction, through knowledge of which we can modify the practical outcome. There is no logical alternative save either to recognize and search for the mechanism of the interplay of personalities that controls the existing distributions of values, or to accept as final a fixed hierarchy of persons in which the leaders assert, on no basis save their own supposed superior personality, certain ends and laws which the mass of men passively receive and imitate. The effort to apply psychology to social affairs means that the determination of ethical values lies not in any set or class, however superior, but in the workings of the social whole; that the explanation is found in the complex interactions and interrelations which constitute this whole. To save personality in all, we must serve all alike—state the achievements of all in terms of mechanism, that is, of the exercise of reciprocal influence. To affirm personality independent of mechanism is to restrict its full meaning to a few, and to make its expression in the few irregular and arbitrary.

The anomaly in our present social life is obvious enough. With tremendous increase in control of nature, in ability to utilize nature for the indefinite extension and multiplication of commodities for human use and satisfaction, we find the actual realization of ends, the enjoyment of values growing unassured and precarious. At times it seems as if we were caught in a contradiction; the more we multiply means, the less certain and general is the use we are able to make of them. No wonder a Carlyle or a Ruskin puts our whole industrial civilization under a ban, while a Tolstoi proclaims a return to the desert. But the only way to see the situation steadily, and to see it as a whole, is to keep in mind that the entire problem is one of the development of science, and of its application to life. Our control of nature with the accompanying output of material commodities is the necessary result of the growth of physical science—of our ability to state things as interconnected parts of a mechanism. Physical science has for the time being far outrun psychical. We have mastered the physical mechanism sufficiently to turn out possible goods; we have not gained a knowledge of the conditions through which possible values become actual in life, and so are still at the mercy of habit, of haphazard, and hence of force.

Psychology, after all, simply states the mechanism through which conscious value and meaning are introduced into human experience. As it makes its way, and is progressively applied to history and all the social sciences, we can anticipate no other outcome than increasing control in the ethical sphere—the nature and extent of which can be best judged by considering the revolution that has taken place in the control of physical nature through a knowledge of her order. Psychology will never provide ready-made materials and prescriptions for the ethical life, any more than physics dictates off-hand the steam engine and the dynamo. But science, both physical and psychological, makes known the conditions upon which certain results depend, and therefore puts at the disposal of life a method for controlling them. Psychology will never tell us just what to do ethically, nor just how to do it. But it will afford us insight into the conditions which control the formation and execution of aims, and thus enable human effort to expend itself sanely, rationally and with assurance. We are not called upon to be either boasters or sentimentalists regarding the possibilities of our science. It is best, for the most part, that we should stick to our particular jobs of investigation and reflection as they come to us. But we certainly are entitled in this daily work to be sustained by the conviction that we are not working in indifference to or at cross-purposes with the practical strivings of our common humanity. The psychologist, in his most remote and technical occupation with mechanism, is contributing his bit to that ordered knowledge which alone enables mankind to secure a larger and to direct a more equal flow of values in life.

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THE MARINE BIOLOGICAL LABORATORY.

THE twelfth annual session of the Marine Biological Laboratory at Woods Holl, Mass., which was held during the past summer, was lacking in none of the elements of interest and success which have made former sessions notable, while several new and valuable features were added last year for the first time. In addition to the regular courses of instruction in Zoology, Embryology and Botany, there was given last year, under the direction of Professor Loeb, a course on Comparative Physiology. Such a course can be given advantageously only at the seashore where living animals of all classes may be had in abundance. In the organization of this course the Woods Holl Laboratory has taken a unique and advanced position which cannot fail to yield valuable results not only to research but also to physiological instruction throughout the country. Another notable feature was the course of lectures and demonstrations in Comparative Psychology given by Dr. Thorndike. This course was followed with the keenest interest by a large number of persons at Woods Holl. The general lectures, a volume of which is published annually, were unusually numerous and valuable. The facilities for dredging in deep water and for making extensive collecting trips were never before so good, thanks to the courtesies of the Fish Commission Station. The United States Fish Commission steamer, *Fishhawk* and schooner *Grampus*, were stationed at Woods Holl and they, with the smaller vessels of the Commission and of the Marine Biological Laboratory, formed a fleet of vessels equipped for scientific work such as has rarely assembled in one place before.

The attendance at the Laboratory was gratifyingly large; there were seventy-one investigators and seventy-eight students, representing sixty-nine different schools, colleges and universities. When it is remembered that there were last year three other marine laboratories on our Atlantic coast, offering their facilities freely, or for much less than the fee at the Marine Biological Laboratory, there is all the more reason for satisfaction at the large number in attendance. In the character and variety of the research work done the past season was not excelled by any preceding one, and in some respects it surpassed them all.

All these features show that the Marine Biological Laboratory is to-day, as much as at any time in its past history, the center of biological instruction and investigation in this country. This can still be said in spite of the fact that there are numerous other marine and fresh water stations in this country, which are doing excellent work and are worthy of generous praise and support. However, no other American station has the national and even cosmopolitan character of the Woods Holl Laboratory; no other enjoys the coöperation of so large a number of educational and scientific institutions, no where else is the whole field of biology so fully represented and no other American laboratory is so productive in original work, nor has so large a number of investigators and students.

The Marine Biological Laboratory is a shining illustration of the fact that men and not buildings nor material equipment make an institution great. There is probably no other educational or scientific institution in the world which on so small a financial basis has accomplished so great a work. This work is of such scientific and educational value and the Laboratory stands for so fine an ideal of scientific coöperation that a brief account of its history and work should not be wholly lacking in interest or suggestiveness.

The Laboratory can claim to be a lineal descendant of the first marine laboratory in America, the school established by Louis Agassiz in 1873, on the island of Penikese, in Buzzards Bay. The Penikese Laboratory was abandoned in 1874 at the close of its second session, after having received in buildings, equipment and endowment, more money than has been given to the Marine Biological Laboratory during the twelve years of its history. This step was made necessary on account of the unfortunate location of the laboratory on an isolated island, and above all by the death of the man whose genius had created it and who alone was able to secure the scientific coöperation necessary to its maintenance. After the closure of the Penikese Laboratory an attempt was made to secure the coöperation of educational and scientific institutions in establishing a marine laboratory at Woods Holl, but the support was not forthcoming at that time and the project was abandoned.

In 1880 the Woman's Educational Association of Boston, acting in coöperation with the Boston Society of Natural History, opened a seaside laboratory at Annisquam, Mass., and this continued in operation for six years. In 1886 the supporters of that laboratory addressed a circular letter to many leading biologists in this country asking their coöperation in the work of establishing the laboratory on a broader basis. In March, 1887, a meeting of persons interested in the enterprise was held in Boston, and a committee was appointed "to perfect plans for the organization of a permanent seaside laboratory, to elect trustees and to devise ways and means for collecting the necessary funds.'' In the spring of 1888 about ten thousand dollars had been secured, and accordingly the Marine Biological Laboratory was incorporated and steps were taken to open it that season. After prolonged consideration the trustees decided to locate the laboratory at Woods Holl, Mass., and the whole history of the institution has shown the wisdom of this decision.

The natural advantages of Woods Holl deserve especial emphasis because they have been fundamental to the success of the Laboratory. In a good location a biological laboratory may be highly successful with very little equipment, while in a poor location no amount of money can make up for this defect.

In 1881 Professor Baird determined to locate the marine laboratory of the U. S. Fish Commission at Woods Holl, after having investigated, during the preceding ten years, almost every available point on the Atlantic coast. It is doubtful whether at any other single place on this coast so many valuable and important features can be found. The only other place seriously considered by Professor Baird was Newport, R. I., and this was finally rejected because of the relative impurity of the water of Narragansett Bay. On the other hand the waters of Buzzards Bay and Vineyard Sound are of exceptional purity, there being no large fresh water streams in the vicinity nor cities discharging their filth into the waters. In the immediate vicinity of Woods Holl are numerous harbors and lagoons, with muddy, sandy or rocky bottoms, while the coast is so broken by bays, promontories, straits and islands as to afford the most varied habitats. In addition the tide currents which sweep in through the sound and 'hole' bring in multitudes of floating animals and plants, many of which are tropical forms carried in from the Gulf Stream, which is distant only about one hundred miles. The proximity of the Gulf Stream to this portion of the New England coast gives a laboratory located at this point many of the advantages of a tropical station without any of the accompanying disadvantages. There are also many fresh water ponds and lakes in the vicinity which contain a rich fauna and flora. Add to these things the fact that Woods Holl

FIG. 1. Main Building, Marine Biological Laboratory.

is readily accessible by rail or boat, that the climate in summer is delightful, the bathing excellent, the mainland and islands charming, the sound with its continual procession of ships always varied and interesting, and you have in Woods Holl not only an ideal place for a laboratory, but also an ideal place for summer residence.

Having determined to locate the Laboratory at Woods Holl, the Trustees bought a small piece of land near the Fish Commission Station and erected upon it a plain wooden building, 63 x 28 feet and two stories high. This was equipped with the most necessary apparatus and the Marine Biological Laboratory was first opened July 17, 1888.

From the first it was determined that the Laboratory should not be under the control of any college, university or other institution, but that it should be truly national in character and that it should invite the coöperation of all persons and institutions interested in the advancement of the science of Biology. Accordingly the Laboratory was organized on an independent foundation.

Its government was vested in a Corporation and a Board of Trustees. The Corporation, at first ten in number, now consists of several hundred persons, many of them present or former students and investigators at the Laboratory, who are interested in its welfare and have contributed to its support. The Corporation elects annually six members of the Board of Trustees, passes upon all proposed changes in the Constitution and By-Laws, hears an annual report from the Director and the Treasurer and makes such recommendations concerning the general policy of the Laboratory as it may desire. The Board of Trustees, at first seven in number, now consists of twenty-seven members, some of them business men of recognized ability, but most of them biologists representing prominent educational institutions in almost every part of the United States and Canada. The Board has direct charge of the property and funds of the Laboratory, elects the Director and Assistant Director, and has general supervision of the scientific work.

From the first the institution has been under the directorship of Professor C. O. Whitman, and it is but simple justice to say that the remarkable success which has attended it is due in large measure to the high ideals and the untiring energy and sacrifice of Professor Whitman. For twelve years he has devoted himself to the Laboratory without compensation and with an enthusiasm which has served to inspire many others with his own ideals concerning the Laboratory and to enlist their hearty coöperation.

In his address at the opening of the Laboratory and in subsequent publications, Professor Whitman took the position that there was great need for a laboratory which should represent, (1) the whole of biology; (2) both teaching and research; (3) the widest possible coöperation of educational and scientific institutions. Such a laboratory should not be merely a collecting station, nor a summer school, nor a scientific work shop, nor a congress of biologists, but all of these; an institution combining in itself the functions and features of the best biological institutes of the world, having the coöperation of the biologists of this country, and thus forming "a national center of instruction and research in every department of Biology." The history of the Laboratory has shown that this ambitious project is not only highly desirable, but that it is entirely feasible and has justified the claim of the Director that such an institution is the greatest need of American biology.

"The new laboratory at Woods Holl," said the director in his first report, "is nothing more and I trust nothing less than a first step toward the establishment of an ideal biological station, organized on a basis broad enough to represent all important features of the several types of laboratories hitherto known in Europe and America. * * * An undertaking of such magnitude cannot be a matter of local interest merely, and if it be pushed with energy and wisdom, it cannot fail to receive the support of the universities, colleges and schools of the country." There was little in the early conditions of the laboratory to justify such high hopes. It began with no assured co-operation, no constituency, a bare building, no library, no private rooms for investigators, only a row boat for collecting and with only two instructors, seven investigators and eight students.

season $1000 was given to establish the Glendower Evans Library; $2500 was raised in Boston to establish two scholarships at the laboratory as a memorial to Lucretia Crocker, long a supervisor in the public schools of Boston. During the third season a lecture hall and library room were constructed as an addition to the building and the 'Gifford Homestead,' together with about one-half acre of land adjoining the Fish Commission was purchased, the house being converted into a dining hall; a steam launch was also secured. In the fifth year an additional laboratory of the size of the original building was constructed. In the seventh year a new laboratory was built for botany and a large dining hall was erected, capable of accommodating two hundred people at one

Fig. 2. Main Building, Botanical Laboratory, Lecture Hall and Research Laboratory.

Since that time the growth of the laboratory in material equipment has been encouraging, while its growth in numbers and in the scope and volume of scientific work has been phenomenal. During the second

time. In the ninth year a building containing a large lecture hall and research laboratories was constructed and a two-masted schooner was added to the fleet of collecting boats.

Although this growth in material equipment has been rapid, the needs of the laboratory have grown still more rapidly. The buildings are all of a temporary character and can be used only in summer; at least one substantial, fire-proof building is needed which can be used the year around; the library is inadequate to the needs of such an institution; the facilities for collecting should be enlarged and increased; the Laboratory is entirely dependent upon the Fish Commission Station for wharf privileges and for pumping sea water to its aquaria and, although cordial and mutually helpful relations have always existed between the two stations, additional land, with shore privileges, ought to be secured while it can be had; above all the Laboratory needs increased endowments both for special purposes, such as scholarships, library, publications, etc., and also for general maintenance.

Fig. 3. Fish Commission Buildings, Wharf and Steamer, one of the Marine Biological Laboratory Buildings on the right.

The growth in material equipment, though encouraging, is overshadowed in importance by the growth in the number of persons in attendance at the Laboratory. In 1888 there were nine investigators and eight students representing thirteen different institutions of learning; in 1899 there were seventy one investigators and seventy-eight students representing sixty-nine different institutions. In all during the twelve sessions there have been in attendance five hundred and ten investigators and seven hundred and forty-five students from nearly three hundred different educational and scientific institutions, while among the occasional lecturers and visitors must be numbered almost all the better known biologists of this country and many from foreign lands.

As the outgrowth of a summer school it might have been expected that the laboratory would give instruction in biological subjects, and at its very beginning its founders resolved that it should also give opportunity for original research. The combination of these two functions at the Laboratory has been a peculiarly fortunate one. It has been proved, not only here, but also in many universities and scientific institutions, that research and teaching are of mutual service. A certain amount of teaching is stimulating to the investigator, while the atmosphere of research is indispensable to good teaching.

When the Laboratory was first established instruction was given in Zoology only, since then courses have been added in Botany, Embryology, Physiology and it is understood that Comparative Psychology and Nature Study will form a part of the regular program hereafter. In these courses there is an earnestness and enthusiasm on the part of students and instructors which is highly stimulating. This is due not only to the exceptional character of the students and instructors, but also to the atmosphere of investigation which prevades the place and which is one of the most helpful features to the beginner, as well as to the advanced worker. Instruction includes not only ordinary laboratory work in the subject named, but also a great deal of observation and collection of living organisms in their natural haunts. Collecting trips and excursions form a regular part of the work, and a most important and enjoyable part. Investigators and even visitors at the Laboratory cheerfully contribute to the work of instruction, and so it generally happens that the lectures are given by men who are specialists in the subjects under consideration and who are able to teach with the enthusiasm, accuracy and directness of 'those having authority.' When it is remembered that the persons in attendance at the laboratory are almost without exception teachers, the tremendous influence of the Laboratory on the teaching of Biology in the schools, colleges and universities of this country can be surmised.

FIG. 4. A Collecting Trip ; Launch and Schooner in the Background.

In 1891 a Supply Department was opened at the Laboratory for the purpose of furnishing to schools and scientific institutions various kinds of biological material to be found in the vicinity of Woods Holl. The collectors studied the best methods of preserving material, the habitats and breeding seasons of various animals, etc., with the result that the Supply Department has been not only a great financial assistance to the Laboratory, but that it has still further contributed to the scientific purposes for which the Laboratory was established. At present a skilled collector is employed the year around and material is gathered, not only from the vicinity of Woods Holl, but from far distant points.

But it is in the work of investigation

that the Laboratory has won greatest renown. The eminent scientific standing of the Director and his co-laborers has served to attract investigators from all parts of the land, until the Woods Holl Laboratory is to-day the Mecca of American biologists and is well and favorably known throughout the world. The list of original contributions which have proceeded from the Laboratory during the past twelve years numbers about three hundred; many of these are large monographs, illustrated with numerous colored plates, and some of them represent unique lines of research. For example, the study of 'cell-lineage,' as it has been called, had its origin at the Woods Holl Laboratory and has so far been confined almost entirely to that institution. This work consists in tracing the cleavage cells, into which the developing eggs of all animals divide, through the whole development until they give rise to larval or adult organs, such as the brain, nerves, sense organs, glands, alimentary canal, etc. This is in all cases a difficult task, frequently taking years of the most painstaking labor, but its results have been of fundamental and far reaching importance. Thanks to this work we now know the cell-lineage of about a score of worms and mollusks. This work has shown that from their first appearance certain cleavage cells are destined to give rise to certain organs; it has shown that, in the groups mentioned, cleavage is as constant in its character as are adult features; that in animals so widely separated as flat-worms, annelids and mollusks these early divisions of the egg are almost identical and that many corresponding cleavage cells give rise to homologous organs. Incidentally such work has shown the close genetic relationship of the groups named; it has also set a new pace in embryology. Now that we know the exact cell origin of these layers and organs, it will never again be possible in describing the development of these animals to refer the origin of certain organs to 'germ layers' merely, nor to refer the origin of these layers to certain general regions of the embryo. The importance of this line of work, not only in the study of the groups named, but also to the science of embryology as a whole, is fully recognized both in this country and abroad, and the credit for this service belongs in large part to the Woods Holl Laboratory.

Other work of the greatest importance has been done in the line of what has been called 'physiological morphology.' It would exceed the limits of this article to give even a brief description of papers of this class which have issued from the Laboratory. A few of the more striking lines of work, however, must be mentioned. Much attention has been given to experiments on the regeneration of lost parts in various animals. In hydroids, sea-anemones and worms these parts are sometimes reproduced in a normal manner, while under different conditions a head may be caused to develop where a tail belongs or *vice versa*. Another line of work has been the grafting together of different parts of animals. One member of the Laboratory succeeded in grafting together in almost every possible manner the pupæ of different moths and butterflies. Some of these afterwards went through the metamorphosis and came out as 'Siamese twins,' 'tandems' with four wings, etc. Another line of work, even more important, is found in 'experimental embryology.' In one famous experiment performed at the Laboratory, the eggs of the sea-urchin were artificially fragmented before they began their development, and in this way twins, triplets, or still more numerous larvæ might be produced from a single egg. If the fragments of the egg were entirely separate, the larvæ which developed were separate and perfect, if they were united, the larvæ were united forming all kinds of double or multiple monsters. Other experiments have shown that certain salt solutions will cause unfertilized eggs to develop for a short time in an irregular way, and only last summer Professor Loeb discovered that he could cause the unfertilized eggs of the sea-urchin to develop into normal larvæ, in short, could produce artificial parthenogenesis in a phylum in which it has never before been known, by treating them with certain salt solutions; this is certainly one of the most remarkable biological discoveries of recent years. The lines of work outlined above, together with many which could not here be mentioned, and which have been actively prosecuted at the Woods Holl Laboratory, have been substantial contributions toward the solution of some of the most fundamental problems of biology.

Each year a course of general lectures on various phases of biological work is given by different members of the Laboratory and by distinguished visitors. These lectures are usually brief accounts of important investigations, presented in a popular form. A volume of these lectures is published annually and the contents of the volumes form a brief index to the multifarious activities of the Laboratory in research. These volumes are not only important contributions to knowledge, but still more, they are brief and popular presentations of what are often abstruse and difficult subjects, and as such they appeal strongly to investigators, teachers and general readers who have not the time to go more fully into these subjects. As showing the opinion of the outside world with regard to these lectures, the following is quoted from *Natural Science*, December, 1899: "Every biologist who is still young enough to be enthusiastic, looks with eagerness about this time of year for the arrival of the volume of 'Biological Lectures' from the Marine Biological Laboratory, Woods Holl, Mass. * * * One cannot help feeling that the intellectual atmosphere of Woods Holl must be bracing, the lectures are so vigorous. The charm of these lectures may be partly due to the circumstances of their delivery, but it is doubtless mainly due to the fact that each is an expression of personal work and personal interest. One cannot but be grateful to the Laboratory at Woods Holl, which has been the stimulus of the fine series to which this volume is added, *Floreat Woods Holl.*" In addition to the volume of lectures there is also published under the auspices of the Laboratory the *Biological Bulletin*, as well as the Annual Reports and Announcements.

The service which the Laboratory has rendered to biological instruction in our schools and colleges and to advanced work in biology in general is incalculable; it is the biological clearing house of this country, where the specialist who has been unable to keep up with the general advance of his science may learn from others what has been transpiring in fields outside his own, where teachers may exchange ideas as to the best methods of instruction, where distinguished men in various fields come to know each other in the most intimate and helpful way, and where all may get broader and truer ideas of the great problems of biology. The Laboratory is also a place to which schools, colleges and universities are coming to look for good men. This feature has never before been emphasized and it receives no direct attention at Woods Hall, but if the indirect influence of the Laboratory in discovering good men and placing them in good positions were known, it would be seen that this feature is no small part of the service which the Marine Biological Laboratory renders to American biology.

The confidence of the Director that the Laboratory would not fail to receive the support of the schools, colleges and universities of the country has been fully justified. During the past twelve years representatives from about three hundred schools and higher institutions of learning have been in attendance at the Laboratory, while twenty-seven colleges and universities and three societies have been regular subscribers to Rooms and Tables. The Laboratory has now grown to such proportions that it cannot expect to draw any large part of its financial support from educational institutions, already overburdened. It is itself an educational and scientific institution of highest rank, and however measured, deserves to stand alongside the best scientific schools and laboratories of the world. "It is acknowledged that only one similar institution in the world (Naples) is more productive in original research, and no other offers even approximately equal advantages for instruction." Such an institution deserves and expects independent support.

The present financial condition of the Laboratory is shown by the following figures:

Total Assets.	
Estimated value of real estate, buildings and equipment at Woods Holl	$35,000.
Invested Funds.	
General Endowment	$ 4,553.
Lucretia Crocker Fund	2,500.
Library Fund	866.
Interest on hand	230.
	$43,149.
Total Liabilities.	
Mortgage on Woods Holl property	$2,900.
Unsecured Loans	5,276.
	$8,176.
Assets less Liabilities	$34,937.

The total earnings of the laboratory as compared with its expenses are given herewith. ('Earnings' include all sources of income save donations only; 'expenses' include all disbursements save those for land, buildings and permanent equipment.)

Total Donations	$37,730.
Earnings	$47,919.
Expenses	$50,759.

It appears from this statement that the income of the Laboratory, like that of scientific and educational institutions in general, is scarcely sufficient to meet the running expenses, and that it must look to the donations of interested friends for assistance in meeting a small annual deficit and for all permanent equipment and enlargement. This is a fact which requires no apology; the Laboratory is not a commercial enterprise but a charitable institution, in the same sense that colleges and universities are such. It is not the purpose of the Laboratory to make money, but rather to contribute as much as possible to the advancement of science, and in this respect it has fulfilled the highest hopes of all its friends. There is every reason to be proud of the fact that it has accomplished so great a work on so small a financial basis, and that it is at present so nearly self-supporting as it is.

The Trustees at their meeting in New Haven, December 29th last, resolved that for the best interests of the Laboratory the out-standing debt of $8,176, should be paid off at once and that a small cash balance should be left in the hands of the Treasurer. They, therefore, appeal to the friends of the Laboratory to contribute $10,000 to this end. Subscriptions may be sent to the Treasurer, D. Blakely Hoar, 220 Devonshire Street, Boston, or to any member of the Board of Trustees.

The time has come also when to give the Laboratory the stable and permanent character which it deserves it should be liberally endowed. Where could a better investment be made than in a scientific and educational institution with such a history behind it and such excellent prospects before? The Laboratory and the ideals for which it stands must not be allowed to suffer for lack of support; it must not remain standing where it is, for although its success has been remarkable, it is only the beginning of what it should and could do, if properly supported. The aim of those who are interested in its welfare is to create a permanent station with adequate endowment and equipment which shall be in the future yet more than in the past 'a national center of research in every department of Biology.'

For this end its friends labor and wait, hoping that the time is not far distant when generous friends of science and education will see its needs and its opportunities and will not be slow in their response.

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REPORT ON THE INITIAL WORK OF THE STATE GEOLOGICAL SURVEY OF NEBRASKA.*

IN a State such as Nebraska where there is no 'mineral'—a term which in the west has come to mean gold and silver-bearing—it is difficult to convince the masses that there is the least possible economic importance in a State geological survey.

If 'mineral' did occur, apathy could much more easily be overcome, and the appeals for a survey would find more willing and receptive ears. But something stronger than apathy is encountered in the prejudice which has been engendered against a State survey by men who have sought heretofore to establish such for the evident purpose of holding office, that is make a political job of it. This prejudice seems justifiable, nevertheless it is none too easy to live down. A good many years have passed since our admission to Statehood, yet Nebraska, a commonwealth greater than all New England, has never made an allowance of any kind for a State survey, not even for the postage and stationery used in correspondence. Literally then not so much as one cent has ever been voted for such work to date. Even moral support has been withheld, save that the titles Acting Botanist, Acting Chemist and Acting Geologist have been conferred. The title being the sole emolument of office. However, the preliminary work of a survey, which has engaged the writer's attention for successive summer vacations since 1891, has just received from the University of Nebraska encouraging recognition, and an allowance, which, though small, is substantial. For the biennium of 1899 and 1900, $1000 was allowed by the Board of Regents for the initial work of a State geological survey. The same sum was likewise allowed for a botanical survey. The sum of $500 a year may seem ridiculously small, yet it made it possible to undertake several lines of work, and fair progress may be reported. Camp outfits were obtained for several field parties. Team and camp accoutrements were procured for Mr. Cassius A. Fisher, a Fellow in the department of geology, who, together with Mr. W. H. H. Moore (U. of N., 1900), constituted a party whose summer was to be spent in examining gravel pits, clay pits, quarries, the water supply, and geology of the southeastern or Carboniferous counties of Nebraska. At each quarry, pit and exposure photographs were taken, measurements and sections made, notes recorded, and liberal samples taken from the soil and sub-soil down through every layer.

One hundred and fifty localities were thus examined. The specimens from each quarry are being mounted in order upon large wooden tablets properly made and finished, each some 7 feet high by one foot wide; these as done are placed permanently on exhibition to illustrate the rock and clay resources of the State. A second party in charge of Mr. C. N. Gould (a Fellow in the department of geology), with Mr. Roy Hadsel (S. W. Kan. College, 1899), as assistant, was provided with team and camp outfit, and drove from Oklohoma through

* Paper read before the Nebraska Academy of Sciences, December 1, 1899.

Kansas, Nebraska, northwestern Iowa into South Dakota, following the Dakota Cretaceous, the great water-bearing beds of the plains. Over one hundred boxes of material were collected, with the result that new forms were found, some valuable rock-bearing beds located, and the second or third largest known collection of Cretaceous leaves made, numbering 4000 to 5000 specimens. Mr. Gould is devoting his undivided energy to these collections, working them out, recording and numbering them, classifying and describing them. This work is to be finished by July 1, 1900.

A third party consisted of Mr. G. E. Condra, a graduate student of the University of Nebraska, who spent the spring and summer collecting the fossil Bryozoa in the Carboniferous exposures, with the result that some 30 localities were visited and a large collection made, in which are already represented over 40 species, several forms being undoubtedly new. Mr. Condra will spend the remainder of the year upon his collections, preparing the material, numbering, recording, identifying and describing the same. Numerous microscopic sections are already cut, and as many more are to be prepared, and this work which was begun two years ago will be continued for at least another year before a paper is to be presented.

A fourth party, consisting of Miss Carrie A. Barbour, assistant curator of the State Museum, and an assistant, visited quarries in the Carboniferous, and Permian for the sole purpose of collecting fossils. Over 20,000 of the commoner species were procured, some of them apparently new to the State, with three or four species supposed to be undescribed. A fifth party consisted of the acting State Geologist, who visited all quarters of the State, and attempted to correlate work as far as he was able. There is such an accumulation of data and material that it will tax the department to dispose of it in time to begin the work of 1900. Besides, several lines of investigation are under way, the most noteworthy of which is that of Mr. W. W. H. Moore, who is making freezing and pressure tests of the mortar, cement and building rocks collected during the summer. This investigation bids fair to yield some useful if not important results. It is the intention that every line of work and investigation shall be so well finished and so nearly in hand that there will be little or no overlapping of the work of one year upon the next. It may be reported that the initial work of the survey seems to be as well systematized as is to be expected the first year. Barring unexpected difficulties and adversities, it seems assured that fair progress may be reported to this academy at the close of the present biennium.

Another sum of $500 will be available for a continuance of the work in 1900, and not less than five or six papers will be ready to submit to the Legislature, as the result of the work of the first biennium. The plan being to ask for a special appropriation for publishing. These papers, according to present intention, will be confined studiously and strictly to economic phases of our geology, with the hope and full expectation that a legislative as well as a university appropriation may be a reality for the second biennium.

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SCIENTIFIC BOOKS.

Text-Book of Vertebrate Zoology. By J. S. Kingsley, Professor of Zoology in Tufts College. New York, Henry Holt & Co. 1899. 8vo., pp. viii + 439. 378 figures in text.

Professor Kingsley has prepared a text-book for college students "intended," so says the preface, "to supplement both lectures and laboratory work and to place in concise form the more important facts and generalizations concerning the vertebrates." The first half of the four hundred odd pages of text is taken up with an account of the morphology of the vertebrates, while the second half is devoted to a systematic review of the group.

In the first half an introductory four pages defines and illustrates the group of chordates and the position of the vertebrates in the group. There follow four pages of introductory embryology, dealing in the briefest and most generalized way with the pre-embryonic stages of development, and then eight pages of general histology.

The organs of vertebrates are then considered under the four heads of entodermal, ectodermal, mesothelial and mesenchymatous organs. The discussion of each is from the embryological standpoint, but includes a consideration of its adult structure. The space given to an organ is necessarily very little, to the teeth two pages, to the tongue half a page, to the cranial nerves eight and one-half pages. This part of the book closes with an account of the segmentation of the head, followed by a brief account of the early development of the egg of vertebrates (oögenesis, spermatogenesis, cleavage, gastrulation) and by a section on the origin of the vertebrates. If one should weave into a single account greatly condensed resumés of Wiedersheim's 'Comparative Anatomy' and Hertwig's 'Text-Book of Embryology,' the result would be very much that which we have here, though Professor Kingsley's combination is skillfully made, clear, generally accurate and brought up to date.

The author is to be congratulated on having the courage to give due recognition in the second part of his book to the importance of a knowledge of vertebrate classification. It is further a matter of congratulation that fossil forms have been included. The treatment is the usual one and this part of the book in its arrangement and general typographical make-up reminds one strongly of Sedgwick's translation of Claus's elementary text-book. It is not to be expected that Professor Kingsley has pleased every one in the matter of classification, that he has prepared a concise and useful summary few will question. Families are briefly characterized; important genera are mentioned; in some cases habitat and common names of genera are added, in other cases only the scientific names appear. But few specific names are mentioned. It is unfortunate that the plan of the book renders this part of it so brief. For purposes of identification it cannot be of great use, but as a convenient means of referring generic names to their families it is of distinct value, and hence the mention, merely, of many generic names is to be commended.

That a book meant for college use should omit references to the literature is a serious blemish.

The index, unfortunately, includes the anatomical and embryological references for the first part of the book only, and the taxonomic terms for the second part only. Thus Cladoselache is referred to page 237, but not to page 173. Even taxonomic terms used in the introductory sections of the systematic part of the book are not fully indexed. Thus Notodelphys is referred to page 287, but not to page 281, where it also occurs; while Rhinoderma, which occurs on the same page, is not indexed. This should be corrected in a later edition.

Among many old friends we find some excellent new illustrations, and many that are rough sketches. Particularly noteworthy are the very useful perspective diagrams, such as Fig. 127. Why, on the other hand, Fig. 16, should be thought worth printing, when so many excellent figures are available, is a mystery. The reproduction of the original figures is frequently bad, the reference lines and letters being often blurred, the latter sometimes illegible. (Figs. 34, 39, 85, 159, 283.) The copied figures are excellently rendered and in other respects the work of the publishers is well done.

Detailed criticism is perhaps superfluous where so much is good, but one wonders how Professor Kingsley overlooked this (p. 25) with reference to the air bladder of the fishes: "The bladder itself usually lies dorsal to the aorta and urinogenital system next the vertebral column." Does not every fisher-boy know better? That archenteron and stomach are synonymous terms, as implied on page 6, and that the duodenum is pre-hepatic, as one might infer from reading the statement at the bottom of page 35, are statements needing revision.

The style of the book is on the whole simple and clear (what does the subject-matter admit of else?), but one is occasionally startled by such English as this (p. 38): "In birds, at about the middle, the mid-gut bears a blind tube," or as this (p. 223): "The lampreys feed upon the mucus and blood which they *rasp* from fishes."

The method of treatment is then strictly morphological—the first part dealing with the morphology of the organs—the second part adding to this so much of external morphology as is of use in classification. Judged as a morphology the book deserves to be commended. But does this warrant the author in calling it a zoology?

A categorical description of the structures of vertebrates so arranged as to suggest their evolution is but a part of zoology. In the opinion of the reviewer it is the least interesting part, and by many modern workers it is regarded as the least important. It would be hard to imagine a college student calling Professor Kingsley's book either interesting or stimulating, though if used as directed in connection with lectures and laboratory work he will surely find it of value. It is easier to point out faults than to show how they may be remedied, but why, may we ask, should three pages be given to the mouth, lips, teeth and tongue, and no word said of the chain of causal relations connecting lip development in mammals with the power of mastication, heterodont dentition and articulate speech, so admirably worked up by Gegenbaur? Why an account of the peculiarities of structure of the Raiæ and no word as to the relation of these peculiarities to the mode of life? And so the rest of it: if we are to have pure morphology, why not more of the spirit of Gegenbaur and less of that of Haeckel? When the ideal text-book of zoology is written it will surely deal with causes, not merely with results.

Jacob Reighard.

University of Michigan.

Water-Supply Engineering: The Designing, Construction and Maintenance of Water-Supply Systems, both City and Irrigation. By A. Prescott Folwell, Associate Professor of Municipal Engineering in Lafayette College. First Edition. New York, John Wiley and Sons. 1900. Octavo, 562 pages and 19 plates. Price, $4.00.

The Filtration of Public Water-Supplies. By Allen Hazen. Third Edition, Revised and Enlarged. New York, John Wiley and Sons. 1900. Octavo, 321 pages and 22 plates. Price, $3.00.

It is a happy feature of American engineering education that many of the text-books used by the student are also manuals constantly consulted by the engineer in making his designs. In such a system of education there is no conflict between theory and practice, but each supplements and improves the other. Theory is indeed merely the systematic formulation of general laws derived from experience, and practice is the application of theory to the economic production of useful results. Both of the above books are well adapted to class use, both exhibit the details of the latest theories and constructions, and both are of high value to the practicing engineer. The first book covers the wide field of all the features of water works, while the second treats of that special part concerned with the improvement of the quality of the water.

Professor Folwell has succeeded well in presenting the principles and practice of this wide field in a single volume. The theoretical discussions may sometimes be criticised as rather incomplete, but it is evidently intended that the reader should have a good knowledge of applied mechanics and hydraulics. The question of the force of impact caused by a moving body or stream of water, which is always puzzling to practical men, especially needs correction and revision on pages 229 and 247. On the whole, however, the theory seems as well presented as can be done in such limited space. The practical details relate largely to the water supplies of cities and towns, irrigation systems being properly given a subordinate place. The subject of designing which includes quantity and quality of water and the details of the systems of collection, purification, and distribution, covers 452 pages, while construction and operation are treated in 94 pages. Methods of cleaning water mains, of thawing out frozen pipes, and of preventing corrosion from electrolysis are well discussed. Pumping systems are treated more fully than usual; this is a step in the right direction, since about 75 per cent. of the water works of the United States are operated by this method, the gravity systems being largely confined to the large towns on the Atlantic and Pacific States. The growing importance of water-supply engineering may be clearly recognized from the fact that the number of water works in the United States in 1898 was about 1600, while in 1897, it was about 3200. The book is well illustrated, clearly written, and will be a valuable aid to all who are planning or operating public water supplies.

The increasing interest in securing purity of water-supplies is not only evidenced by the circumstance that the book of Mr. Hazen has reached its third edition in less than four years, but also by the construction of sand filter beds at seventeen American towns and cities in the last decade. During the same period more than one hundred others have installed mechanical filtration plants. No fact in sanitary engineering is, indeed, more fully established than that the death rate from typhoid fever is materially lowered by filtration, and the present interest of the public gives hope that the time is not far distant when the cities of the United States may take rank with London, Berlin, Vienna, and Amsterdam in freedom from that disease. Mr. Hazen is a high authority on this subject, and, although an advocate of the system of slow filtration through sand beds, his book treats also of the more rapid system of mechanical filters, which in many cases may be installed at less expense. The present edition gives the results of the recent experiments at Louisville, Pittsburg, and Cincinnati, and also valuable information regarding the filter beds of several European cities. Statistics of both systems of filtration are presented in tabular form. These show that the slow sand system is used by cities having an aggregate population of 21,400,000, of of which 10,200,000 are in Great Britain and 260,000 in the United States. The aggregate population using mechanical filters in the United States and Canada is nearly 1,600,000, while this system is practically unemployed in other countries. At the present time only about one-tenth of the cities and towns of the United States have filtered water supplies. The book of Mr. Hazen, as well as the large plant recently built at Albany, N. Y., under his supervision, will have much influence in inducing other cities to inaugurate effective methods for the purification of their water supplies.

MANSFIELD MERRIMAN.

California Mines and Minerals. Published by the California Miners' Association, under the direction of EDWARD H. BENJAMIN, Secretary for the California Meeting of the American Institute of Mining Engineers. San Francisco, Calif. 1899. Vol. 8. Pp. 450.

This treatise upon the mines and mining of California is dedicated to the members of the American Institute of Mining Engineers 'as a souvenir of their visit to California' in September and October, 1899; but it is a vastly more important and valuable work than the usual 'souvenir.' It constitutes a very valuable treatise upon the great industry to which it is devoted and is full of important information, valuable historical facts and industrial statistics. It is a large volume, handsomely printed, extensively and well illustrated, well made and substantially bound. Its market value is stated to be five dollars and the munificence of the Californian is well exhibited in the fact that a copy was supplied to every member of the visiting Society.

The contents consist of thirty-five papers by well-informed writers and often the ablest in their respective departments. In these chapters are described the topography, geology and mineral deposits of the various mining counties of the State, the methods of working, the statistics of production, and the special conditions of exploitation and development of the more interesting fields, especially those in which the precious metals are produced in largest quantity. Regarding the most important products, gold and silver, copper, borax, bituminous and asphaltic rock, quicksilver, and petroleum, the ground is remarkably well covered. We note that the output of silver has less value than that of petroleum and that quicksilver has fifty per cent. larger value than the former.

Numerous half-tone and other illustrations, maps and tables of statistics aid the reader in obtaining a most satisfactory understanding of the extent and importance of the mining industries of California.

R. H. T.

BOOKS RECEIVED.

Richter's Organic Chemistry. Edited by PROFESSOR R. ANSCHÜTZ. Translated by EDGAR F. SMITH. Third American Edition. Philadelphia, P. Blakiston's Son & Co. 1900. Vol. II., pp. vi + 671. $3.00.

Malay Magic. WALTER WILLIAM SKEAT. With preface by C. O. BLAGDEN. London and New York, The Macmillan Company. 1900. Pp. xiv + 665. $6.50.

Lessons in Elementary Physiology. THOMAS H. HUXLEY. Edited by FREDERIC S. LEE. New York and London. 1900. Pp. xvi + 577.

The Teaching of Elementary Mathematics. DAVID E. SMITH. New York and London, The Macmillan Company. 1900. Pp. xv + 312. $1.00.

SCIENTIFIC JOURNALS AND ARTICLES.

The Plant World for February has for its leading article 'Notes on the Edible Berries of Alaska,' by Walter H. Evans, who states that they are of wonderful abundance and variety. John M. Coulter treats of the 'Geograpical Distribution of Conifers,' Byron D. Halsted presents a note on 'Coloration of Leaf for Seed Distribution,' and K. C. Davis discusses the 'Wild and Garden Pæonies in America.' Mrs. Caroline A. Creevey continues her series of articles on 'Plant Juices and their Commercial Values,' amber, copal and turpentine being among those discussed in this number. The Supplement on 'The Families of Flowering Plants' contains the Ginkgoales, the Pinaceæ and the Taxaceæ.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

THE 97th regular meeting was held at the Cosmos Club, February 14, 1900.

Under informal communications, Mr. Bailey Willis stated that a diamond drill hole at The Dalles, on the Columbia River, had reached a depth of 916 feet and had penetrated several flows of Columbia basalt, distinguished by layers of clay and by differences of texture. No exact section has been kept. A piece of core from 916 feet in depth is shown by examination in thin section to be basalt. The object of the boring, which is a private enterprise, is to prospect for coal.

Mr. H. W. Turner proposed the adoption and use of the term *Sierran*, originally suggested by Professor Le Conte, to distinguish the erosion interval of the early Pleistocene. The actuality and importance of this early Pleistocene erosion were illustrated with reference to the eastern slope of the Sierra Nevada. It was shown that the *Sierran* cañons had in some cases been occupied by lava flows upon which the moraines of Glacial time are resting.

The following papers were presented on the regular program:

(1) 'A peculiar Clastic Dike and its Associated Ore Deposits,' by Mr. F. L. Ransome. This dike is exposed in the workings of the Wedge and Bachelor mines, near Ouray, Colorado. It fills a normal fault-fissure, of small throw, cutting nearly horizontal beds of sandstone and shale. The filling material came from above, and is largely composed of flakes of black shale, derived from a bed which is traversed by the fissure, but which limit the upward extension of the dike. This material was subsequently forced by pressure into all the branches of the fissure and has the form of an eruptive dike. It has been explored to a depth of 630 feet and has an average width of 2 or 3 feet. The ore, which is an argentiferous tetrahedrite, or freibergite, occurs alongside of, or in the dike, in spaces opened by later movements. These have been in part bedding faults, which have dislocated the dike along nearly horizontal planes.

(2) 'Wood River Mining District, Idaho,' by Mr. Waldemar Lindgren. The silver-lead mines of Wood River are located in southern central Idaho, some 50 miles north of Snake River. The geological formations consist of a sharply folded series of Paleozoic, probably very largely Carboniferous, sediments consisting of limestones, quartzites, and slates. Imperfect fossils indicating Upper Carboniferous were found in it at two localities. The large granite area of southern Idaho abuts against the sedimentary

rocks in this vicinity, showing at the contact undoubted intrusive phenomena. The Carboniferous series contains several isolated masses of granitic rocks of varying character, which are also intrusive into the sediments.

The deposits are fissure-veins with a west to northwesterly strike and southerly dip, occurring, as a rule, in the calcareous shales of the sedimentary formation. The principal minerals are galena and zincblende in a gangue of predominating siderite. Veins of the same character are also found in the granite areas enclosed in the sediments. The veins are pre-Miocene and post-Carbonifereus in age, their crossings being in part covered by andesitic flows. The granitic rocks also contain another series of veins of very different composition. They carry chiefly gold contained in pyrrhotite, chalcopyrite, pyrite, and arsenopyrite. Replacement has played an important part in the vein formation, especially in those veins which are contained in the sedimentary areas. The fissure plans are well defined but the ore-bodies do not follow these strictly in detail, and may exhibit considerable irregularity.

(3) 'Cretaceous fossils collected by J. B. Hatcher in Patagonia,' by Mr. T. W. Stanton. Among the collections brought back by Mr. Hatcher's last expedition to Patagonia there are some Cretaceous invertebrates that seem to represent a fauna new to South America. The localities from which they were obtained are near Lake Puerrydon in Latitude 47° 30′ S. and Longitude 72° W. There are about 35 species in the collection of which 28 are sufficiently well represented to be described and these all appear to be new. Although there are some indications of relationships with Lower Cretaceous faunas, consideration of the collection as a whole leads to the conclusion that the horizon is about the middle of the Cretaceous, at least not lower than the Gault.

F. L. RANSOME,
DAVID WHITE,
Secretaries.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 318th meeting was held on Saturday, February 10th. H. J. Webber exhibited photographs of the Melon Pawpaw, *Carica papaya*, which is a native of both the East and West Indies. The form native in Florida has a fruit about the size of an egg, but the cultivated varieties (of which there are several) bear fruits from the size of a small musk melon up to five or ten pounds in weight. The fruit is pyriform and much resembles a musk melon in taste and make-up and is sliced and eaten in the same way.

The most noteworthy character of the plant is its well known faculty of rendering meat tender when cooked with it. This is due to the presence of a soluble ferment known as papain which is similar in action to the animal pepsin. The fruit of *Carica* also contains this ferment in considerable quantity and bids fair to become a very valuable desert fruit, especially for invalids troubled with indigestion. It is a fruit which should be more widely known and sold in all markets.

Henry W. Olds spoke on 'Form in the Songs of Birds,' showing first that the study of bird music, while interesting, is of little, if any, value as an aid to the development of the science of ornithology. He then considered the question of the use of our scale. He gave a brief resumé of its evolution and stated that, wonderful as it seems, it is a fact that some of the birds do use our scale. He instanced several that unmistakably are governed by the intervals that compose it, although some of them occasionally wander from the key just as human singers do. Mr. Olds then considered various essential forms that give to music coherence and capability of æsthetic satisfaction. These he illustrated with blackboard notations and whistled examples of both human and avian music. He showed different means by which is produced that symmetry that is needed to satisfy the musical sense—the regular recurrence of phrases or kinds of phrases, repetition of one theme on different pitches, the regularity of these repetitions, antiphonal or answering themes, etc., and for every example in our music instanced its counterpart among bird songs he had noted. In conclusion he suggested that these were not accidental resemblances, but seemed to show on the part of the birds intelligent appreciation of musical effects; and that there appeared to be no escape from the conclusion that the birds were subject to a musical evolution that paralleled our own.

Mr. M. G. Kains presented a paper upon 'The Effects of the Electric Arc Light in the Culture of Easter Lilies,' giving the results of experiments conducted during the winter of 1895, at Cornell University, under the direction of Professor L. H. Bailey. Three divisions of the plants were made, one in the full glare of the naked light, one in which the light first passed through a pane of glass, and one where no light was employed. The light burned nightly for four months and uniform cultural conditions were maintained throughout the tests. Plants in the light sections were taller, blossomed earlier, were less robust and their flowers shorter lived than those grown in the dark, blossoms in the naked light exhibited a dark brown burn upon the surface facing the lamp, and blossoms upon plants grown in the dark lasted two days longer than those in the light. From the experiments it is concluded that commercial use might be made of the arc light after the lily buds are an inch long, and that the light must pass through a glass to screen out the ultra-violet rays of the spectrum.

E. V. Wilcox discussed 'Lupines as Plants Poisonous to Stock,' saying that cattle and sheep varied greatly in their liking for the growing plants, some animals eating them with avidity and others caring little for them. The poisonous properties of the Lupines appeared to reside in the seeds or seed pods, for, while the plants were usually eaten with impunity, great mortality had been known to occur among stock which was forced by a fall of wet snow to feed on plants from which the leaves had mostly fallen while the seed pods remained. On the large ranges of the west, where forage plants were not cultivated, Lupines were frequently so abundant that they were cut and dried like hay for use in winter, and the speaker noted a case where sheep fed on this Lupine hay were seemingly driven mad.

T. W. Stanton,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

The 512th meeting of the Society was held on February 3, 1900, at the Cosmos Club. After a general discussion on the method of publication of the *Bulletin*, the first regular paper of the evening was read by Mr. J. G. Hagen, on 'Recent Progress in Astro-physics.'

During the course of the address the following three points were discussed: *The cluster type* of *variable stars*, the *spectroscopic binaries*, and the *Potsdam photometric catalogue.*

Regarding the first point, the cluster Messier No. 5 was mentioned as presenting a remarkable uniformity in its variable stars. Out of 900, visible on the plates obtained in Arequipa with the 13-inch Boyden refractor, 63 were recognized as variables, and 40 of them were measured accurately from nearly a hundred plates. The mean period of all except two is about 12½ hours, with a mean range of 1.1 magnitude. It was suggested that, with Pogson's light factor 0.4, the common range of 1.1 magnitude could be explained by supposing each variable to be a binary system, with components of equal brightness. The cluster would then consist of many binary systems, each with its orbital plane passing through the sun, and with a period of revolution equal to 25 hours.

With respect to spectroscopic binaries, Campbell's discovery of Polaris as a double system was mentioned. The center of gravity approaches our sun with a velocity of 12 kilometers, while Polaris oscillates around it in a period of about four days. The fact that three years previous the mean velocity was found eight kilometers larger, might point to a disturbing body. Yet, to pronounce Polaris a triple system, would be premature. Another interesting discovery of a periodic change in the spectrum was recently made by Mrs. Fleming in the case of Zeta Centauri, with intervals of two and six days, thus making a period of eight days. The intervals of two and six days were graphically illustrated by an eccentric orbit. Attention was also called to experiments made by Humphrey, Mohler and Wilsing, to the effect that changes in the normal spectrum may be produced by changes of pressure in the source of light.

The third point consisted in a summary of a review of the Potsdam photometric catalogue, recently published in the *Vierteljahrsschrift*, XXXIV., pp. 288–297.

At the close of the paper two Goerz Trieder Binoculars were exhibited.

The second paper read was by Mr. J. F. Hayford, on 'Recent Progress in Geodesy.' As it is expected that this will soon be published in SCIENCE in full, no abstract is here given.

A paper by Mr. T. J. J. See, on 'Recent Progress in Astronomy,' went over to the next meeting on account of the absence of the author.

E. D. PRESTON,
Secretary.

TORREY BOTANICAL CLUB.

THE annual meeting on January 9th, resulted in the election of the previous board of officers, including as *President*, Hon. Addison Brown; *Treasurer*, Maturin L. Delafield, Jr.; *Secretary*, Edward S. Burgess, Ph.D.; *Editor*, Lucien M. Underwood, Ph.D. Annual reports of officers were rendered, that of the Treasurer showing a balance in the treasury.

The Secretary, Professor Edward S. Burgess, reported an average attendance of 31 at the 15 meetings held during the year, one death, a present active membership of 237, corresponding membership 142, honorary membership 3, total membership 382. Among the 18 scientific papers presented, 5 had been accompanied by lantern views; 4 papers related to ferns. Nine illustrative exhibits of photographs, plates and flower paintings, etc., had been held. Brief reports of collections and of botanical progress numbered 55.

The editor, Professor L. M. Underwood, reported the regular monthly issue of the *Bulletin*, forming the largest volume published to date, including 650 pages, besides 23 heliotype plates and 38 figures in the text, and including 65 articles representing 39 authors. The publication of the *Memoirs* has been carried on with unusual activity, including Dr. M. A. Howe's monograph on the Californian Hepaticæ (208 pages, 35 plates), Mr. Tracy E. Hazen's Life-history of '*Sphærella lacustris* (*Hæmatococcus pluvialis*'), pp. 33, 2 colored plates, and the beginning of Professor F. E. Lloyd's 'Comparative Embryology of the Rubiaceæ' (pp. 21, 4 plates).

Miss Ingersoll, as curator, reported upon the condition of the herbarium of the Torrey Club, suggesting its transfer to the New York Botanical Garden. Discussion followed looking toward its treatment there as the nucleus for a distinct local collection, but no definite action was taken. Dr. T. F. Allen remarked upon the beginnings of the collection as dating from a persistent botanical exploration of parts of New Jersey, especially about New Durham and the Secaucus swamps, made by himself and Mr. Wm. H. Leggett, Dr. Bunstead, etc.

Dr. Allen's own private herbarium at Litchfield, Ct., is also richly representative of those localities and others now destroyed or altered, and contains much of interest to the history of local botany of New York City.

Miss Marie L. Sanial, as Secretary of the Excursion Committee, reported 38 excursions held, with the new feature of excursions for bryological and other collections in December, at one of which 15 persons were present.

The Committee appointed to consider a program for a Torrey Day in connection with the A. A. A. S. meeting here next summer, reported through the Secretary, a provisional program.

The scientific paper of the evening was by Professor Francis E. Lloyd, on 'The Relationships of certain Rubiaceæ,' forming part of an investigation in the embryology of that order now in course of printing among the *Memoirs* of the Torrey Club. The ground of relationship considered was the ovary, which is classed as inferior, but developmentally proves a receptacle hollowed out. The flower seems to be derived from one or more separate corolla-lobes. The Rubiaceæ are very polymorphic externally, and there is the greater need of discovery of stable internal characters. Such characters for the ovary of the Stellateæ were discussed in detail. That of the common Buttonbush, *Cephalanthus*, was alluded to as possessing certain ovary characters in form and relatively rapid and prolonged growth of the basal partition, which accord most significantly with the unusually compressed position of the ovary.

Discussion followed regarding the passage of pollen tube through tissues rather than loosely in the cavity of the ovary. In some Rubiaceæ, said Professor Lloyd, these tubes seem stimulated by contact with the enlarged collar-cells of the funiculus, and appear to owe their guidance into the micropyle to such stimulus. Dr. MacDougal remarked upon recent conclusions that pollen tubes show negative reactions to oxygen, but positive to sugars, and to albuminoid substances in the ovary or near the embryo-sac.

Edward S. Burgess,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The February meeting of the New York Section of the American Chemical Society was held at the Chemist's Club, 108 West 55th street, on Friday evening, the 9th inst., Dr. C. F. McKenna presiding. After consideration of a series of resolutions submitted by the Committee on Standards for Instruments of Measure, the following papers were read: 'The Technical Analysis of Rope and Twine,' by Durand Woodman; 'A New Synthesis in the Phen-Miazin Series,' by Marston Taylor Bogert; 'On the History of Photo-Chemical Improvements,' by Maximilian Toch.

Dr. Woodman described the chief commercial grades of Cordage, 'oiled' and 'unoiled,' 'tarred,' 'plumbagoed,' etc., and exhibited samples of manila, sisal and jute fiber with analyses; also analyses of the different grades of rope above mentioned.

Dr. Bogert described a new method of preparing the salts of the Phen-miazin series as developed in the organic laboratories of Columbia University, which consists in heating anthranilic acid with any nitrile in a sealed tube for several hours at a temperature of 200 degrees to 250 degrees C., according to the nitrile used. Since many foreign chemists, as well as several in this country, are working on this same subject, it is very gratifying to have a successful result on a new line of experiment from the University in this city.

Mr. Maximilian Toch described chiefly the progress in photo-chemistry, and illustrated the method of printing and developing some of the more rapid bromide papers. His paper was listened to with great attention and was followed by remarks and reminiscences from several members

Durand Woodman,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of February 5, 1900, some 250 persons were given a demonstration of the use of the microscope in the sciences, arts and industries, by experts, under the direction of Dr. H. M. Whelpley, as follows:

Anatomy, Dr. R. J. Terry; *Bacteriology*, Dr. Amand Ravold; *Blood examination*, Dr. Ludwig Bremer; *Botany*, Mr. H. F. Roberts; *Diseases of forest trees*, Dr. H. von Schrenk; *Drug adulterations*, Mr. O. H. Elbrecht; *Flour inspection*, Mr. Victor Goetz; *Insects parasitic on man*, Mr. C. F. Baker, *Living protoplasm*, Dr. Otto A. Wall, Jr.; *Microphotography*, Mr. Robert Benecke; *Mineralogy*, Dr. G. Hambach; *Photographic dry plate testing*, Mr. Robert Benecke; *Photomicography*, Dr. Adolph Alt; *Physiology*, Dr. Hartwell N. Lyon; *Seed adulterations*, Mr. F. W. Maas; *Spice adulterations*, Mr. William K. Ilhart; *Textile fibers*, Mr. Peter J. Weber, Jr.; *Trichina*, Dr. G. C. Crandall.

Through the courtesy of the Historical Society, the rooms of that Society were thrown open to the members of the Academy and their guests, and the Society's important collections, as well as the demonstration offered by the Academy, proved a source of interest and instruction to the ladies and gentlemen present.

William Trelease,
Recording Secretary.

NOTES ON PHYSICS.

DRUDE'S ANNALEN.

A new series (the fourth series) of the *Annalen der Physik*, begins with the current number, January, 1900, under the editorship of Paul Drude. This great periodical will now be known as *Drude's Annalen*. The third series, the *Annalen der Physik und Chemie*, edited by G. and E. Wiedemann, contains sixty-nine volumes. The entire series, 305 volumes to date, represents a large part of the progress of the physical sciences during the eighteenth and nineteenth centuries.

RADIANT HEAT.

Professor Max Planck gives, in *Drude's Annalen*, January, 1900, a reprint of his electro-magnetic theory of radiation which was communicated to the Berlin Academy of Sciences in May, 1899. This memoir, which seems to be monumental in character, is remarkable in that it verifies the Stefan-Boltzmann law, derived from thermodynamic considerations, that the total energy radiant from a black body is proportional to the fourth power of the absolute temperature, and the law of W. Wien concerning the distribution of energy in the spectrum of a black body.

Wien's conclusions are based upon certain assumptions as to the number of radiant centers (molecules) in unit volume and their velocity. It is now known that the total energy radiated from a black body and its distribution in the spectrum depend only upon temperature and are entirely independent of the physical properties of particular substances, so that it is highly probable that the law of total energy and the law of its distribution in the spectrum are capable of rigorous derivation from assumptions of axiomatic simplicity.

The theoretical results of Stefan, Boltzmann and Wien, now verified by Planck, may, therefore, eventually appear to be independent of the highly specialized character of the assumptions upon which they are based. When this stage of the science is reached, these laws of radiation will no longer appeal to experiment for verification, but they will take their place among numerous other established laws as instruments for the interpretation of experimental results.

Physicists ought to drop the term radiant energy and retain the older and better term radiant heat, inasmuch as the energy of radiation is heat in the same sense that molecular energy is heat. Both types of energy are subject to the first and second laws of thermodynamics; both types give rise to the entropy function, and Maxwell's law of molecular velocity distribution is strictly analogous to Wien's law of the distribution of energy in the spectrum.

THERMAL CONDUCTIVITY.

HEAT measurements are among the most inaccurate of physical measurements and the measurement of thermal conductivity is perhaps the most inaccurate of the measurements in heat. Professor Kohlrausch (*Drude's Annalen*, January, 1900) proposes a method for measuring thermal conductivity which depends upon the final permanent distribution of temperature in a conductor carrying electric current, heat being allowed to flow out of the conductor only at the points where current enters and leaves it. Under these conditions a remarkably simple relation subsists between the temperature at a point, the electric potential at a point, and the ratio of electrical to thermal conductivity. The method depends only upon measurements of temperature, of electrical potential, and of electrical conductivity. W. S. F.

ENGINEERING NOTES.

A NUMBER of European nations are now adopting the Gruson chilled iron shield for their land defences and the success of the invention is so well-assured, it is said, that the Messrs. Krupp, some time since, bought the *Grusonwerke* and have developed the invention to a state of considerable perfection. The Gruson armor-turrets are thought to be practically invulnerable; their flatly curved tops deflecting shot and shell and their adamantine chilled surfaces and their great thickness making them impenetrable to direct impact of the heaviest shot. It is proposed to endeavor to introduce this device into the United States, where it is thought that it may be made even more successful, since our chilling irons are found to be superior to those of any other country. The turrets are usually of from 50 to 100 tons weight and are built up of great staves and segments, ten or fifteen of which constitute the low, wide, circular, covered box which constitutes the turret and protects the guns. The top is usually made of two semi-circular halves. In their manufacture, the quality of iron employed is presumably that found to make the best car wheels and one of peculiar strength and toughness, as well as of intensely hard chilling property. A *Grusonwork* is to be established at Chester, Pa., by New York and Philadelphia capitalists.

THE success of the submarine craft which have been recently produced in the United States and in France is stimulating other nations, and an authority among English technical journals—*Industries and Iron*—says: "In spite of the derision with which they have been received by our Admiralty, there is a prospect of submarine torpedo boats, becoming an important factor in the future strategy of marine warfare. Apart from the ancient history of diving or submarine torpedo boats, the recent activity, notably of the French and American naval authorities, and the favorable views with which the experts of these two nations look upon the latest developments in submarine torpedo boats, is more than ample justification for our Admiralty giving serious consideration to this most dangerous and constantly improving mode of torpedo attack. Our battleships are estimated to be worth £40,000,000 and our protected cruisers about £26,000,000, whilst other fighting ships of our Navy are valued at about £34,000,000, making in all a grand total of £100,000,000. Surely if our costly Navy is to be menaced with such a system of deadly torpedo attacks as may reasonably be anticipated from the modern submarine boats of foreign naval Powers, it behooves our Government to test and adopt counteracting means of attack, and also to endeavor to secure some more reliable means of defence against such attacks than at present obtain in our Navy.''

THE last year was the 'record year' for Great Britain as well as for the United States. That country registered a foreign trade totaling about four thousand dollars. The imports were £485,000,000, of £12 per capita of total population, the exports £264,000,000, about £6 // 11s, per capita and the re-exports £65, averaging £1 // 12s. There has never been a year in which so much trade was reported, so much manufacturing done or so much profit secured; notwithstanding the enormous amount of successful competition in the British market and the markets of the world, to which the United States and Germany have attained. Prosperity has been quite extraordinary in all manufacturing and exporting countries.

R. H. T.

BOTANICAL NOTES.

BOTANY AT WOODS HOLL.

FOR about a dozen years opportunities for botanical study have been offered to botanists at the Marine Biological Laboratory at Woods Holl, a seaside town on the southern coast of Massachusetts. Year by year the work offered has been enlarged, so that now, under the direction of Dr. B. M. Davis, of the University of Chicago, it includes a laboratory study of algæ, fungi, plant physiology, plant cytology and micro-technique, with lectures covering nearly the whole field of botany. The laboratories are open from July 5th to August 16th.

When we think of the poor preparation of so many of our teachers of botany in the high schools, and even the colleges and the so-called universities, it is strange that more of them do not take advantage of the opportunities offered by such a school as this at Woods Holl. It is encouraging to see that already eighteen colleges are coöperating in supporting this laboratory school. There should be many more of these. Every large institution should offer as a prize to its advanced men a room or table in the Woods Holl Laboratory. In many cases this would be of much more value to the recipient than a scholarship or fellowship costing the institution much more money. These might be called 'Woods Holl Scholarships,' the recipient to spend the season in work in the laboratory, and to bring back into his college at the end of the summer vacation the results of his studies.

MINNESOTA BOTANICAL STUDIES.

THE thick 'part' of this interesting and unique publication which appeared early in January, contains articles on *Chlorochytrium* (an endophytic alga of the Protococcaceae, found in the thallus of a marine seaweed), *Rhodymenia* (a red seaweed from the Pacific Coast), the Lichens of the Lake Superior Region (enumerating one hundred and fifty-eight species and varieties, forty-six of which had not hitherto been recorded from the interior flora of the United States), Lichens of the Minnesota Valley (enumerating two hundred and one species and varieties of which forty-one had not hitherto been recorded from Minnesota, one being new to science), Synonymic Conspectus of Native and Garden Aquilegias of North America (describing forty-six species and varieties), Synonymic Conspectus of the Native and Garden Aconitums of North America (describing seventeen species and varieties).

HARPER'S STUDIES IN CELL DIVISION.

THE December number of the Annals of Botany contains another of those valuable contributions to plant cytology which have appeared from time to time from the hand of Professor Harper. He takes up in the present paper the cell-division in sporangia and asci, using for the former mainly the species of *Saprolegnia* and *Achlya*, with some of the *Mucoraceae* and *Synchitriaceae*, also. For the cell-division of asci he has made use of his previous studies in the *Erysipheae*, and now adds *Lachnea scutellata* of the *Pezizaceae*. His summary of results is in part as follows:

"If we compare now the methods of spore-formation in the ascus and in the sporangia studied, the differences in the two cases are at once apparent. In the ascus, as in the higher plants, the cutting out of the daughter cell from the mother cell is effected by the agency of the same fibrous kinoplasmic elements as were concerned in the division of the nucleus. In the higher plants the flat cell-plate is formed by the 'cone-principal' of the karyokinetic figure as named by Van Beneden, while in the ascus the daughter cell is cut out of the protoplasm of the mother cell by an ellipsoidal cell plate formed from the fibers of the antipodal cone. In this process the daughter cell is cut out of the interior of the protoplasm of the mother cell, so that it remains surrounded on all sides by the material of the mother cell. The daughter cells do not contain all the protoplasm of the mother cell, a considerable mass remaining as the so-called epiplasm. This is typical free cell-formation, as I have pointed out before. In all the sporangia studied, the cleavage is from the surface of the protoplasm, or from the surface of vacuoles of the mother cell. The daughter cells are thus separated by cleavage-furrows, and the nature of the division from the surface inwards precludes the possibility of the formation of an epiplasm. * * *

"If we consider now the bearing of the observations presented, on the doctrine that the ascus is a more highly developed and specialized modification of the sporangium of the Zygomycetes, it is plain that the very different methods of cleavage in the two cases are opposed to the assumption of any close relationship between them. In fact, it seems rather difficult to imagine any intermediate stages which could connect the process of cleavage by surface-furrows, as seen in the sporangium, with the free cell-formation of the ascus. * * *

"The total dissimilarity of the process of cleavage in the sporangia described and the ascus as I have shown it in the above account, makes it necessary to look for the ancestors of the Ascomycetes elsewhere than in the lower Fungi. Thaxter's studies of the Laboulbeniaceae have emphasized greatly the resemblance of that group to the Florideae and the hypothesis of the multiple origin of the Fungi from the Algae has gained correspondingly in strength. * * *

"We can say, however, as noted above, that the unlikeness in the method of spore-formation in the ascus and the sporangia which I have studied, makes it impossible to assume any very direct relationship between the Phycomycetes and Ascomycetes."

SHORT NOTES.

COULTER and Rose contribute an important paper to the Proceedings of the Washington Academy of Sciences, consisting of a synopsis of Mexican and Central America Umbelliferae, in which all the data with respect to the umbelliferous flora of the region under consideration are brought together. Thirty-nine genera and one hundred and eighty-two species are enumerated.

AN interesting paper by O. Borge of Stockholm, on the fresh-water algae of Franz-Josefs-Land (Süsswasseralgen von Franz-Josefs-Land, Köngl. Vetens. Akad. Förhandl, 1899) enumerates the plants collected by the Jackson-Harmsworth Expedition. No less than forty-three species, representing twenty-two genera, are enumerated. These genera range from *Oscillatoria*, *Nostoc*, etc., to *Cosmarium*, *Spirogyra*, *Vaucheria* and *Oedogonium*. One new species is described, namely, *Monostroma fisheri*, of which, oddly enough, a variety, also (var. *minor*) was found.

C. G. LLOYD continues his 'Mycological Notes' (No. 4, November, 1899) and takes up the genus *Psalliota*, describing six species and varieties, and enumerating eighteen or twenty others which have been recorded as occurring in this country. Some of the latter are rare, some of doubtful occurrence, while others are based on erroneous determinations.

The report of the Botanist of the United States Department of Agriculture, recently issued, gives one some idea of the many kinds of work taken up by that division, including poisonous plants, seed testing, seed and plant introduction, economic plants of the tropics, etc.

Botanists may obtain a suggestion as to how to secure the publication of some of the matters they wish to distribute to the people, from a tiny pamphlet on the 'Stinking Smut of Wheat,' by Professor Bolley, of the North Dakota Agricultural College, which was 'published for the farmers of Minnesota and North Dakota' by one of the enterprising railway lines. It is popularly written, and at the same time is scientifically reliable.

Recent 'Contributions to the Flora of Queensland' by F. M. Bailey, Colonial Botanist, enumerate and describe many new plants, and call attention to certain plants 'reputed to be poisonous to stock.'

A recent report on the 'Timber Trees of the Herberton District of North Queensland,' by J. F. Bailey, assistant to the Colonial Botanist, is interesting to American botanists on account of the fact that but one of the genera enumerated (*Zanthoxylon*) is native to this country. One obtains little idea of the appearance of the Queensland forests from an examination of the descriptive list of one hundred and eleven names. What notion, for example, does one have of species of *Acronychia* and *Halfordia* (Rutaceae), or *Blepharocarya*, *Euroschinus* and *Pleiogynium* (Anacardiaceae), or *Aleurites*, *Baloghia* and *Mallotus* (Euphorbiaceae)?

The successive numbers of the *Forester*, 'a monthly magazine devoted to the care and use of forests and forest trees and to related subjects' contain so much that is botanical, and are so beautifully illustrated that we cannot do otherwise than commend it to botanists as a most helpful journal.

Charles E. Bessey.
The University of Nebraska.

SCIENTIFIC NOTES AND NEWS.

Sir Michael Foster has been returned to Parliament as representative of the University of London. The final vote was: Sir Michael Foster, 1271; Dr. Collins, 863; Dr. Busk, 586.

The Paris Academy of Sciences has elected as a corresponding member, Dr. H. G. Zeuthen, professor of mathematics at the University of Copenhagen.

Professor C. Barus, of Brown University, has been asked by the committee in charge to present a report on pyrometry at the International Congress of Physicists of the Paris Exposition.

Professor Ira Remsen, of Johns Hopkins University, will deliver the address at the dedication of the new chemistry building of the University of Kansas next fall.

The following named botanists and zoologists have recently joined the Washington Academy of Sciences as non-resident members: C. E. Bessey, University of Nebraska; John M. Coulter, University of Chicago; G. L. Goodale, Harvard University; C. S. Sargent, Arnold Arboretum; W. P. Wilson, Philadelphia Commercial Museums; W. B. Scott, Princeton University; Henry F. Osborn, Columbia University; David S. Jordan, Stanford University; William Brewster, Cambridge, Mass.; J. A. Allen, American Museum of Natural History; E. A. Andrews, Johns Hopkins University; H. C. Bumpus, Brown University; Carl H. Eigenmann, Indiana University; Walter Faxon, Harvard University; Chas. H. Fernald, Mass. Agricultural College, S. A. Forbes, University of Illinois; Simon H. Gage, Cornell University; Samuel Garman, Museum of Comparative Zoology, Cambridge; Alpheus Hyatt, Boston Society of Natural History; C. C. Nutting, State University of Iowa; Arnold E. Ortmann, Princeton University; W. E. Ritter, University of California; R. E. C. Stearns, Los Angeles, California; R. P. Whitfield, American Museum of Natural History; Edmund B. Wilson, Columbia University.

As we have already announced, Professor R. W. Wood, of the University of Wisconsin, is at present in England, having been invited by the Society of Arts to lecture on 'The Method of

Color Photography by Means of Diffraction Gratings,' which he has described in this JOURNAL. This lecture was announced for February 14th. Professor Wood was invited while in London to lecture before the Royal Society on February 15th, his subject being 'Photographs of Sound Waves and the Kinematographic Demonstration of the Evolution of Reflected Wave Fronts,' and before the Physical Society on February 23d, on these and several of his other recent discoveries in physics. He has also been invited to lecture before the Royal Photographic Society and the Camera Club.

WE learn from the *Botanical Gazette* that Dr. Douglass A. Campbell, professor of botany, in Leland Stanford University, has been spending some time in the University of Berlin and is at present in Egypt.

THE Prussian Ministry of State has expelled Dr. Arons, docent in physics at the University of Berlin. It will be remembered that charges were brought against Dr. Arons for advocating the doctrines of social democratic party and that the University Senate refused to discipline him.

WE regret to record the death of President James H. Smart of Purdue University, Lafayette, Ind.

THE death is announced of Professor Charles Piazzi Smyth, the astronomer. He was the son of Admiral William Henry Smyth, a well known hydrographer and astronomer, and was born at Naples in 1819. He began his astronomical work at the Cape of Good Hope in 1835 and was appointed Astronomer Royal of Scotland and Director of the University of Edinburgh in 1885. He is best known to the general public for his publications on the 'Great Pyramid.'

THE death is also announced of Mr. Leander J. McCormick who founded the observatory at the University of Virginia which bears his name.

THE Royal Institution, London, has received for the promotion of experimental research at low temperatures, £100 from Sir Andrew Noble. The Institution has also received £100 from Mr. Charles Hawksley, and £25 from Mr. Frank McClean.

EX-REPRESENTATIVE Isaac Stephenson of Marinette, Wis., has announced his intention to give to that city a public library building, to cost $50,000.

ON the evening of February 21st, the Trustees of the Corcoran Gallery of Art, at Washington, D. C., gave a reception to the Washington Academy of Sciences and their guests, the American Institute of Mining Engineers. The spacious halls of the gallery were thrown open and a considerable assemblage was present notwithstanding a very stormy evening.

THE following delegates representing scientific organizations, have been assigned from the District of Columbia to attend the Pure Food and Drug Congress: *District of Columbia Chemical Society:* Professor W. H. Seaman, W. H. Krug, Professor Charles L. Reese, W. E. Patrick, J. K. Haywood, A. L. Brown; *Department of Agriculture:* Secretary James Wilson, Dr. D. E. Salmon, Dr. H. W. Wiley, William Saunders, Mr. W. N. Irvin, J. H. Brigham, Dr. W. D. Bigelow; *Army Medical Department:* Lieut.-Col. Charles Smart, Dr. William M. Mew; *Navy Medical Department:* Medical Director, Charles H. White; *Health Department District of Columbia:* Dr. Wm. C. Woodward, Professor J. D. Hird, Mr. H. C. McLean, Dr. W. C. Fowler; *American Pomological Society:* Professor Wm. A. Taylor; *Commissioners of Pharmacy:* Dr. John T. Winter, Dr. W. P. Carr, G. G. C. Simms; *Pharmaceutical Association:* W. G. Duckett, H. A. Johnston, R. M. Harper; *College of Pharmacy:* W. S. Thompson, F. M. Criswell, S. T. Hilton.

THE preliminary announcement has been issued for an International Congress of General Botany to be held at Paris from the 1st to the 10th of October of the present year. The official language of the Congress will be French, but papers in other languages will be accepted if they are accompanied by a brief abstract in French. Abstracts must be received not later than September 16th. The president of Congress is M. Prillieux, and the secretary, M. Perrot, École Supérieure de Pharmacie, Paris.

AN International Congress of Navigation will be held at Paris from July 28th to August 3d. It will include in its scope not only navigation of the sea, but also the navigation of rivers and canals.

THE House Committee of Mines and Mining has acted favorably on a bill creating a department of mines and mining, with a cabinet minister. The Geological Survey would be transferred to this department. There is also, as we have also reported, a bill before Congress establishing a department of Commerce and Manufactures, to which it is proposed to transfer the U. S. Geological Survey, as well as the U. S. Coast and Geodetic Survey, the Patent Office, the Commission of Fish and Fisheries, and the Bureau of Navigation. The Treasury Bureau of Statistics and the Bureau of Foreign Commerce of the State Department are to be consolidated into a single bureau of the department. The principal new offices created are the secretary and assistant secretary of commerce and industries, the secretary receiving a salary of $8000 and the assistant secretary $4000.

THE Ontario government has completed arrangements for the formation of a forest of almost 3000 square miles, embracing the district in which Lakes Temagami and Lady Evelyn are situated. The bulk of the reserve is virgin forest, with the finest white pine in Canada upon it.

THERE were 533 deaths from the plague in Bombay during the week ending February 16th. Up to February 17th there have been 42 cases of the plague and 32 deaths at Manila. The influenza is seriously epidemic throughout Europe and has been increasing during the past two weeks in New York and other cities.

FOR the accommodations of those who wish to view the eclipse of the sun, which takes place on May 28th, Messrs. Cook have arranged a conducted tour, leaving London, May 21st, visiting Paris, Bordeaux, Biarritz, Madrid and Talavera, where the total phase of the eclipse will be visible.

A TELEGRAM has been received at the Harvard College Observatory from Professor Kreutz, at Kiel Observatory, stating that "Comet *a* was observed by Javelle at Nice, Feb. $17.^d3148$ Greenwich Mean Time, in R. A. $2^h\ 22^m\ 2^s.8$ and Dec. $-1°\ 19'\ 27''$." The check word shows that there is an error in this telegram, although it has been correctly repeated from Kiel. A cablegram, asking information, was sent to Professor Kreutz, but no reply has yet been received. If we assume an error of 10° in the addition, the message will check. The observation can not have been made on February 18th.

THE thirty-fifth volume of the *Zoological Record* has come to hand. Although chiefly relating to the year 1898, it includes the literature of the Coelenterata for 1897 and 1898. Copies may be obtained of the Secretary of the Zoological Society of London. Price, 30 shillings.

A NEW edition—the second—of 'Recent and Coming Eclipses' by Sir Norman Lockyer is now ready. It contains an account of the observations made at Viziadarog, in India, in 1898, and of the conditions of the eclipses visible in 1900, 1901 and 1905.

THE Duke of Devonshire and the President of the Board of Trade received, on February 5th, a deputation which presented a memorial asking for the continued maintenance of the Buckland Museum of Economic Fish Culture. The memorial stated, as we learn from the London *Times*, that the late Frank Buckland, who was appointed one of her Majesty's Inspectors of Fisheries in 1866, formed the museum at his own expense to aid the practical study of fish and fisheries and to teach people, through the eye, their practical value. He cast for it, mostly with his own hands, 400 specimens of fish, and collected a large number of objects illustrating fish and oyster cultivation and preservation and the modes of taking fish. This museum he bequeathed to the nation on trust to form part of the national collection at South Kensington Museum, and he also bequeathed £5,000, after his widow's death, to found a professorship of economic fish culture in connection with the museum. The gift and its conditions were formally accepted by the Department of Science and Art in 1881; but in 1898 the Select Committee appointed to inquire into and report upon the administration and cost of the museums of the Science and Art Department recommended that the Museum of Fish Culture should be abolished. The memorialists offer various reasons why this recommendation ought not to be sanctioned. Among other things they recall the fact that at the closing ceremony of the Fisheries Exhibition of 1883 the Prince of Wales said: "I think our duty towards the supporters of the exhibition will not be discharged until we have done something towards the promotion of that application of science to practice from which the fishing industry, like all other industries, can alone look for improvements." The Prince proposed the formation of a society having for its objects the collection of statistics and other information relative to fisheries, the diffusion among the fishing population of a knowledge of all improvements in the methods and appliances of their calling, the discussion of questions bearing upon fishing interests, and the elucidation of those problems of natural history which bear upon the subject. To extend the usefulness of the museum on these lines, and also on lines suggested by Professor Huxley, the coöperation of the Board of Trade appears to the memorialists to be essential. They suggest various directions in which such coöperation could be usefully afforded by inspectors of fisheries and others, and they submit that to disperse or neglect the museum would be a retrograde step unworthy of a great maritime country, a breach of an engagement of the Government, and an injustice to the memory of an able public servant. They ask that the museum shall be maintained and exhibited at South Kensington permanently and in a proper and efficient manner in accordance with the terms of the bequest accepted by the Department of Science and Art, and that such steps may be taken, in accordance with the suggestions of the Prince of Wales, as may be deemed expedient for securing its permanent usefulness in the interests of the river and sea fisheries of the United Kingdom. The memorial is signed by the Dukes of Richmond, Bedford, Northumberland, Sutherland, Westminster, and Abercorn, the Marquises of Tweeddale, Bute, Dufferin, Worcester, and Granby, the Earls of Home, Stamford, Sandwich, Jersey, Portsmouth, Radnor, Kimberley, and March, Lord George Hamilton, Viscount Powerscourt, Viscount Folkestone, Lords Massy, Chelmsford, Tweedmouth, and St. Levan, Lord Justice A. L. Smith, Sir William Harcourt, Sir Edward Birkbeck, together with representatives of the Fishmongers' Company, of various fishery boards and angling societies, inspectors of fisheries, and many others.

UNIVERSITY AND EDUCATIONAL NEWS.

INSTRUCTION IN ARCHÆOLOGY AND ETHNOLOGY IN THE UNIVERSITY OF PENNSYLVANIA.

DR. DANIEL G. BRINTON, for thirteen years Professor of American Archæology and Languages in the University of Pennsylvania, died July 30, 1899. His death was more than a great loss to the University—it was in a sense an irreparable loss. He had long been recognized as foremost among the students of the aboriginal languages of North America, and in that branch of research no one could be found to take his place. Dr. Brinton himself, however, shortly before his death, took steps towards ensuring in the University the permanence of the work to which he had devoted himself. He presented to the institution his library of works relating to the aboriginal languages of North America, comprising about 3000 volumes and embracing a large number of unpublished manuscripts as well as nearly all the printed material now extant. He had also recommended the appointment of his friend and co-worker, Mr. Stewart Culin, as Lecturer in Ethnology and American Archæology, and shortly after his death Mr. Culin was named for that position by the authorities of the Graduate School and was appointed by the Board of Trustees.

Mr. Culin has long been connected with the Museums of the University, and is now the curator of the Section of Asia, and General Ethnology. He is the author of between twenty and thirty published papers and monographs, and is best known by his work on Games. He was the first to show definitely that the games of all civilized races are descended from certain divinatory practices, many of which still exist among primitive peoples with their original significance unobscured.

During the year 1900–1901 Mr. Culin will offer courses upon the outlines of American

Archæology and upon Comparative Ethnology. In order to systematize still further the work offered in Archæology, Dr. Hillprecht, Professor of Semitic Philology and Archæology; Dr. Clay, Lecturer in Assyrian, Hebrew and Semitic Archæology, and Dr. Bates, Lecturer in Greek and Classical Archæology, have been associated with Mr. Culin in the administrative group entitled Archæology and Ethnology, and will offer courses next year in Babylonian and Early Hebrew and Phenecian Paleography. The Life and Customs of the Early Babylonians, Hebrew Archæology, Greek Epigraphy and Greek inscriptions.

It is the intention of the University to develop the work in Archæology and Ethnology in connection with the Free Museum of Science and Art. The collections now in the Museum offer students of Early Babylonian Archæology opportunities unrivalled in America, and in some respects unexcelled in the world. The material relating to the primitive culture of North America and of Borneo is also very rich, and that relating to Egyptian and Classical Archæology is sufficient to render substantial aid to instructors in those departments.

GENERAL.

President Gilman of Johns Hopkins University has made a plea before the finance committee of the Maryland Senate for a renewed State appropriation of $50,000 annually for two years. After enumerating the losses sustained by the university in the depreciation of Baltimore and Ohio Railroad stock values and the suspension of dividends, he said: The expense of maintaining the university is not far from $200,000 a year. The income from investments is $100,000. The income from tuition, $50,000. These are all round numbers, varying a little year by year. Unless the deficit of $50,000 can be made up, contraction must follow. Contraction will bring great discredit, for it will be known throughout the land. Students will drop out and a period of anxiety will follow. The university has no debts. Its capital invested in land, buildings, books and apparatus, is $1,000,000. It has excellent friends, wide reputation, and the hopeful prospects of large gifts. But it cannot anticipate the legacies which are known to be drawn in its favor. What is needed is a continuance of the aid which the last Legislature gave for two years more.

The condition of affairs at the University of Cincinnati is extremely unfortunate. The University occupies a somewhat peculiar position being a municipal institution with its Board of Directors appointed by the Superior Court of Cincinnati. It was founded by a citizen of the city with a considerable endowment and has received gifts from other citizens; but it has received its site and central building from the city and obtains three-tenths of a mill from the city tax list. It is regarded as the head of the public educational system of Cincinnati and the students are nearly all from the city. The experiment of a municipal university is certainly interesting and it is unfortunate that its future is at present endangered by political and personal factions. The condition of affairs has already been briefly reported in this Journal. Of the twelve members of the academic faculty, eight have been compelled to withdraw, no definite charges having been made. Several of them are men of science with established reputation. Of the four remaining professors one has resigned as a protest against the action of the Directors. He has published an open letter condemning in very outspoken language the action of the president. At a meeting of the Board of Directors on February 19th, a committee of citizens presented a protest, but the Board refused to give the Faculty a hearing.

Mr. James Russell Parsons, Jr., has been elected Secretary of the University of the State of New York.

Dr. Wilhelm Wien, professor of physics at Giessen, has been called to Würzburg as successor to Professor Röntgen.

Dr. Stanislaus Ciechanowski has been appointed assistant professor in the University of Crakow, and Professor v. Hertling, of Munich, has been called to the professorship of philosophy at Bonn, in the place of the late Dr. Neuhäuser.

Dr. E. Ashkinass has qualified as docent for physics in the University of Berlin, and Dr. U. Belu for physics and Dr. Reitter for chemistry in the University of Bonn.

SCIENCE

FRIDAY, MARCH 9, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

PROFESSOR THOMAS EGLESTON.

THOMAS EGLESTON, planner and first professor of the School of Mines of Columbia University, died on Monday morning, January 15th, at his home, 35 West Washington Square, New York City, at the age of sixty-seven years.

Professor Egleston was born in New York City, December 9, 1832. He prepared for college under Dr. Dudley, of Northampton, took the regular four years' classical course at Yale and graduated in 1854; and in the following year took a post graduate course in the Yale Scientific School of Analytical Chemistry under Professor Benjamin Silliman, Jr.

In 1856 he went to Europe more for rest than to pursue any special course of study, but, becoming interested in the lectures in geology and chemistry at the Jardin des Plantes of Paris, he spent a good deal of time in the collections and laboratories and later, desiring to pursue more systematic work, applied for and obtained the permission of the government to attend certain lectures at the École des Mines, especially those of Professor de Senarmont on Mineralogy, of Elie de Beaumont on Geology, and of Professor Bayle on Paleontology. He completed his course at the school in 1860, having not only attended the lectures but worked in all the laboratories. During the vacations and at the close of his course he travelled extensively in France and Germany, studying and collecting.

In 1861 Mr. Egleston returned to New York city and was at once chosen by the Smithsonian Institution at Washington to take charge of the work of sorting and arranging the specimens of minerals and rocks which had accumulated as a result of various exploring expeditions. To facilitate the work and assist in the system of international exchanges then undertaken, he prepared a check list of minerals with their compositions, which was published by the Institution.

At this time the need for a school of mines and metallurgy in this country was beginning to be recognized. Schools of civil engineering existed and schools of science, but nothing especially devoted to mining or metallurgy. Mining operations were conducted by so called 'practical miners,' with here and there a graduate of a foreign school, and the waste and mismanagement were almost beyond belief.

The nearest previous approach to the formation of such a school is found in the incorporation in New York State, about 1859, of the 'American School of Mines' with the avowed object of "The economic and scientific development of the mineral wealth of the United States, the determination of its economic values, instruction in the art of practical mining and the analysis and composition of mineral products." This institution does not appear ever to have reached a stage of active existence.

Dr. Egleston prepared and published in March, 1863, a 'Proposed Plan for a School of Mines and Metallurgy in New York City,' which was simple and practical and founded undoubtedly upon the methods pursued at the École des Mines. In about 1500 words he stated the object of the school, the proposed course of instruction, and the estimated cost of establishment.

The object stated was "To furnish to the student the means of acquiring a thorough scientific and practical knowledge of those branches of science which relate to mining and the working up of the mineral resources of this country, and to supply to those engaged in mining and metallurgical operations, persons competent to take charge of new or old works and to conduct them on thoroughly scientific principles." A course of three years was outlined which was closely adhered to for the first few years of the school and then gradually modified. The estimated cost of equipment was $17,300, of which over half was for collections.

Dr. Egleston's idea appears to have been to graft the school upon some existing institution, and fortunately he submitted the plan to the Trustees of Columbia College, who for four or five years had been considering the extension of the work of the college by the establishment of graduate schools, among others a 'practical school of science.' The opportunity to make a first step in this direction seemed to exist in the plan of Dr. Egleston, for it was proposed to pay all expenses of the school from the fees, and while the organization as planned required a larger outlay than the financial condition of the college warranted, the committee of the Trustees reported that, "the nucleus of such a school could be formed at inconsiderable cost to the college and so as to be capable of expansion whenever the means of the college shall permit." The Trustees, thereupon set apart rooms in the college building for mineralogical and geological collections, appropriated $500, for fitting up cases and, on February 1, 1864, appointed Thomas Egleston, Jr., Professor of Mineralogy and Metallurgy without salary.

Although no money was appropriated with which to buy collections of minerals or rocks, the small collection of the college was placed at the disposal of the new school, and Dr. Egleston obtained gifts from Mr. George T. Strong and the Hon. Gouverneur Kemble, with which two private collections of considerable value were purchased. From these, before the opening of the school, he formed a very fair working collection of minerals and a smaller geological collection.

An assay room, with a furnace for every four students, and a chemical laboratory were fitted up in one of the cellars. As one of the first students writes: "Though the actual state of these necessary aids to study was not good, the collections were all planned on a great scale and as far as possible the work was done thoroughly. The assay laboratory was the best in the country, the crystal models for every day use more abundant and complete than in any other school in the world. The best design was sought in tables and cabinets, and with all its shortcomings the new institution not only gave full promise of its present state of perfection, but was in fact superior in some respects to any existing at the time."

On November 15, 1864, the school opened with fifteen students, which by the end of the month had risen to twenty-nine and a little later to forty-three, the list including graduates of common schools and colleges, business men and civil engineers in full practice.

Early in 1865 the trustees recognized the success of the experiment and definitely made the School of Mines a coördinate branch of Columbia College. It has steadily developed, widening by the addition of courses in civil engineering, chemistry, architecture, electrical engineering, sanitary engineering and mechanical engineering into the existing cluster of schools in applied science under one faculty, with 1300 graduates and over 2000 others who have attended partial or special courses.

In the first four years of the School of Mines Dr. Egleston devoted himself to the preparation of lectures in mineralogy and metallurgy, to the accumulating and bringing into shape the mineralogical collection and to the preparation of needed text-books. All his publications prior to 1872, with the exception of a report upon a 'geological and Agricultural Survey of the first hundred miles of the Union Pacific Railroad,' which he conducted in 1866, were text-books, tables and catalogues for the use of students of the School of Mines. It is noteworthy that while Dr. Egleston's first love was mineralogy and, as he expressed it, he "only took charge of metallurgy because at the time he could not persuade anyone else to take it," yet after the completion of his text-books in mineralogy he did little or no work in this direction, except in the development of the collection. In the collection work he never relaxed and even the year of his retirement, when grievously broken in health, insisted on personally choosing and setting in the new specimens.

In metallurgy, on the contrary, he published nearly one hundred books and papers, covering a wide field and to a very great extent the result of data collected in his yearly trips to different parts of the world. This complete passing into metallurgy was practically coincident with and in a measure caused by the founding of the American Institute of Mining Engineers in 1871. Dr. Egleston was approved for membership at the first meeting and thereafter for over twenty years was one of its most vigorous members, twice a manager, three times vice-president, and in 1887 president. He contributed to their transactions over thirty articles, and in this same period he published over twenty articles, principally metallurgical, in the *School of Mines Quarterly*, and contributed also papers to the American Society of Civil Engineers and American Society of Mechanical Engineers, The New York Academy of Sciences, and in the *London Engineering* he published a long series of articles upon the Metallurgy of Silver, Gold and Mercury in the United States, which, with other matter, were reprinted in two large volumes in 1887 and 1890, and constitute his most ambitious work.

Aside from his scientific work, Dr. Egleston took a very active part in religious and charitable work. He was a vestryman of Trinity Church for twenty years, and at the time of his death was Junior Warden, as well as member of several committees. For nearly thirty years he was Vice-President of the Protestant Episcopal Mission Society and a Trustee of the General Theological Seminary. He is also to be credited with the establishment of 'Food Kitchens' in New York, and with organizing the Public Parks Association by which Washington Square was saved. The Audubon Monument movement was also started by him.

In 1874 Princeton conferred upon him the degree of Ph.D., and Trinity that of LL.D. In 1890 he was appointed a Chevalier of the Legion of Honor by the French government on the recommendation of the Director and members of the Faculty of the École des Mines. In 1895 he was made 'Officier.' It is pleasant to record also that since his death the Trustees of Columbia University have named the Museum of Mineralogy the 'Egleston Mineralogical Museum,' thus attaching his name permanently to the collection which he created and loved.

In 1896 his health gave way, and though after a rest he endeavored to resume his work, he could not stand the strain and was retired June 30, 1897, at his own request, as Professor Emeritus.

The service of Dr. Egleston to science lies not so much in his numerous writings, though these contain an enormous mass of valuable information collected with infinite labor and published always when and where they were needed. Far more important was what has been happily called 'his intuitive perception of the situation,' his recognition of when the time was ripe to inaugurate a movement, his skill in organization and the amazing vigor, persistency and unfailing belief with which he forced it to success.

Alfred J. Moses.

THE SEVENTIETH BIRTHDAY OF CARL VON KUPFFER.—HIS LIFE AND WORKS.

Professor von Kupffer has lately passed the mark of three score years and ten and has received the congratulations of his students of many lands. Some of these, following the good German custom, have prepared memoirs in his honor which appear in a memorial volume and were presented him as a birthday gift. Von Kupffer has been a most helpful friend to the Americans who have carried on their investigations in the Anatomical Institute in Munich during the past generation, and it seems but just that at this time an American journal should pay a tribute to his life and work.—Editor of Science.

Carl von Kupffer ranks to-day as one who has taken a place within the innermost circle of comparative embryologists. He has long been recognized as a profound scholar in a broad field of zoological knowledge; he is best known, however, for his researches upon the structure, development and descent of the vertebrates.

In his biography von Kupffer presents an interesting parallel with the great embryologist, Karl Ernst von Baer. Both were natives of the Baltic provinces of Russia, students and graduates of the University of Dorpat, and sometime practicing physicians until drawn into zootomical-embryological research. Both were for a time professors at Königsberg, and showed a distinct bent towards the widely separate themes of Arctic exploration and craniology; they were equally interested in matters relating to fish and fishery and contributed important memoirs to this subject. On the other hand they had in general but little leaning towards work of the systematst.

Both left Königsberg for wider fields, von Baer, however, to largely lay aside his embryological researches, the other to extend and correlate his. An interesting difference between the two embryologists is this, that von Baer had completed his most important work when he was scarcely over forty years of age, while von Kupffer had not begun his best known work until he was over sixty. A further difference is that Kupffer has held fast to the early themes of his research. Von Baer lived until his eighty-sixth year; von Kupffer has entered his eighth decade with every prospect of many years of active work.

Von Kupffer has devoted forty-five years to his researches. And these he has embodied in upwards of fifty memoirs. The number seems relatively small—the bibliography of von Baer is six times as great—but this is explained by the fact that the papers are mainly of a critical character and are the fruit of intricate and time-consuming studies, just as von Baer's 'Entwicklungsgeschichte der Thiere' was the outcome of no less than nine years' of assiduous labor.

The writings of von Kupffer deal in the main with problems in special fields of embryology. A number of his well-known papers are contributions to histology, and there are several dealing with craniology, including the memoirs on the skull of his illustrious predecessor in Königsberg, Immanuel Kant.

The histological work of von Kupffer extends over a wide range of subjects. To cytologists he is known as a pioneer in the study of the ultimate nature of protoplasm. Thus, according to Bütschli, he ranks as the first to demonstrate satisfactorily the reticulo-vesicular character of protoplasm in living tissue. His observations in 1870 in the follicle cells of Ascidia showed distinctly the reticular meshwork and the breaking up of the cytoplasm into ultimate 'vesicles.' He also indicated for the first time (1870) the radial arrangement of the alveoli around the nucleus, together with the 'marginal alveolar layer.' The term 'paraplasm' used by von Kupffer in 1875, is still in use (as the equivalent of what at present is more often known as 'metaplasm') although in a somewhat different sense than that in which it was first used. His sustained interest in this theme was lately shown in his inaugural address (1896) as rector of the University of Munich.

The processes of the fertilization of the egg have been described by him in several forms. In an early paper on this subject he expressed his belief that in large meroblastic eggs a process of physiological polyspermy occurs, a view which his student, Professor Rückert, and other investigators have since confirmed and extended. His studies on fertilization have thus been important as leading the way for other papers from his laboratory—such for example as those on the fertilization of the lamprey and of the teleost by his devoted friend, Dr. A. A. Böhm, and also the earlier work of Theodor Boveri.

Von Kupffer's work should next be noted in connection with the structure of glands. In his studies on the histology of the liver he proved the presence of the secreting vacuoles in the gland cells and of the intralobular fibrous sheath. He next discovered the remarkable Sternzellen (or 'Kupffer's cells') in the wall of the portal capillaries: these he showed were not nervous, as was at first believed, but highly modified endothelial cells, and later he demonstrated their function as phagocytes. His researches on the development of the mammalian kidney should here be mentioned: these he carried on by means of serial sections cut by free hand—this was long before the time when section cutting became general—and by this means he was able to demonstrate more satisfactorily than had hitherto been done the early separation of the mesonephric from the metanephric kidney, and he first showed the essential relations of the permanent kidney and its ureter to the mesonephric duct.

Another of his histological works deals with the structure of the stomach, in this in a measure preparing a way for the exhaustive comparative studies of his student, Professor Oppel. Other contributions relate to the development of the liver, spleen and pancreas (in *Ammocoetes*) and afford striking evidence that these organs are closely related genetically. Further papers discuss the characters of muscle cells, and the origin of blood in the valves in the dorsal vessel of the leech (*Rhynchobdella*). In his earlier work he was also attracted into the puzzling field of the electric organs in fishes (*Gymnotus*, *Mormyrus* and *Malapterurus*).

Another and perhaps the most important line of his histological work relates to the structure of nerves. He thus demonstrated that the axis cylinder was not a solid structure in the sense of the earlier investigators. This condition he showed was artifact: the 'cylinder' is rather to be looked upon as an axial canal containing in its fluid contents the delicate fibrils. In the matter of the central origin of nerve fibers his further observations have yielded a basis of the new neurone theory. The difficult question as to the exact mode of termination of nerve cells in an end-organ he also successfully answered in one of his earlier papers; in the salivary gland (*Blatta*) he was able to trace the final arborescence of the nerve filaments on the wall of the gland cell and he described the discoidal enlargement at the tip of each fibril.

Von Kupffer had never played the rôle of a pioneer in any extended field of embryological research. He has done the work—which has only too often the greater value—of extending, correcting and interpreting the results of earlier observers. Thus his famous work on the development of the Ascidian was in the path which had been opened by Kowalewsky, whose results, as von Kupffer himself notes, were then almost universally discredited. Von Kupffer soon came to support the new cause and he even outdid Kowalewsky himself in advocating the closer affinities of the ascidians and chordates. He thus showed in the ascidian the continuity of the cord and brain, the 'segmentation' of the tail, the presence of 'spinal nerves,' and the distinctly chordate character of the notochord, together, later, with interesting homologies in the sense organs. And so too in his extended paper on the development of the Lamprey he took up the unfinished work, and succeeded in reconciling several discrepancies in the results of Max. Schultze and Shipley. But it should be understood that the results of pioneer investigators were to von Kupffer but as the foundation stones of detailed and original work. Thus in his paper on the lamprey he soon laid aside his purely critical studies and attacked a series of difficult problems relating to the origin of the mouth, the cranial nerves, and of the primitive conditions of the central nervous system.

Gastrulation is one of the most difficult processes with which the student of the development of vertebrates has to deal. And it is upon this theme that the work of von Kupffer has thrown no little light. It was formerly thought—and this was the rock which wrecked the results of Pander, Baer, and Rathke—that in the large yolk-filled eggs of such animals as reptiles and birds the germ-layers of the embryo arise one from the other by a process of splitting (delamination). Von Kupffer, however, was able to demonstrate that in these forms a process of infolding occurs, modified, it is true, but proving that the gastrulation of the higher forms is clearly homologous with that of the amphibia and many fishes.

He was also the first to give a satisfactory interpretation to a characteristic structure of the gastrulation of the meroblastic types, the primitive streak. An especially remarkable feature of von Kupffer's work was that he made his interpretation of the invaginate character of the early gastrula of a meroblastic type in his study of the teleost—a form in which the appearance of the infolding process is so difficult to observe that his early results were for thirty years discredited—and it is only recently that the 'prostoma' in these forms is again described (Sumner). It was his earliest paper on teleostean development, by the way (Ref. No. 6, II.), which describes 'Kupffer's vesicle,' which in the matters of its homology and function has since been an unusually fruitful theme for controversy. We may note in passing that von Kupffer believed that the region of the prostoma was (as he also interpreted the primitive streak of amniotes) the *only* region of gastrulation in the bony-fish, that he failed to determine the invaginate character of the germ ring, and that he interpreted the early embryo as equivalent to the primitive streak, and not therefore to the actual embryo.

In connection with Kupffer's work on the development of the teleosts it should be mentioned that it is he who deserves the credit for the view that the cells of the blastoderm are the progenitors of the periblast nuclei, and that they also give rise to the tissue cells of the embryo, questions of great theoretical importance. His work on the development of the herring, undertaken in the interest of the Commission for the Investigation of the Fisheries of the German Ocean, is a further memorable contribution to the biology of fishes. Here for the first time in any extended embryological memoir photo-micrographs were introduced as plates.

Only a tithe of von Kupffer's publications relate to the development of mammals. His most noteworthy paper deals with the question of the 'inversion of the germ layers' which had been described in a rodents, a condition which appeared to be an extraordinary contradiction to the usual mode of origin of the germ layers. By means of a series of stages of the field-mouse he showed conclusively, however, that this 'inversion' was only apparent: during early growth the embryonic area bowed downward to the ventral side of the ovum, so that the flattened gut came to be apposed to the surface while the central nervous system was left to develop within the cavity of the ovum.

The philosophy of the vertebrate head has furnished the fruitful theme of von Kupffer's studies during the past ten years. And his memoirs (three of the series have thus far appeared) upon this subject are, I think, regarded generally as his *magnum opus*. His endeavor in these memoirs is to demonstrate by ontogenetic conditions in the lowest craniotes the mode of origin, phylogenetic, of the structures of the vertebrate head—brain, cranial nerves, sense organs, mouth region, muscles and skeleton. The plan of this series accordingly recalls somewhat that of Dohrn in his 'Urgeschichte der Wirbeltiere,' although the views of their authors are usually widely at variance. Von Kupffer derives the ground plan of the conditions of the vertebrate head from that in the protochordates while Dohrn, for a long time, at least, has been the strong supporter of the famous annelid theory. Certain it is that the results of von Kupffer are welcomed by the warmest interest even by those whose faith in the great value of developmental characters as tests of phylogeny has been severely shaken. And all will admit he has already been able to clear up a number of doubtful points in cranial problems: thus, to mention but an instance or two of the general value of his work, it is now found possible to determine definitely the most anterior point of the brain and to compare with certainty—thanks to his revision of topography—such widely distinct and important regions as those of the lobus olfactorius impar, the recessus opticus and the tuberculum posterius, in all chordates from amphioxus to man. So, too, his determination of the metameral characters and subdivisions of the cranial nerves bids fair to become a classic if not an epoch-making contribution to the philosophical side of this long investgated and difficult subject.

In a late number of the Münchener Medicinische Wochenschrift, Professor Rückert* pays a tribute to von Kupffer's remarkable power of continuing and improving the quality of his work in spite of the burden of seventy years, and he concludes his paper with the wish that von Kupffer will long be spared to continue his good work. In this wish his American colleagues heartily join.

Bashford Dean.

The following bibliography of von Kupffer is largely due to the kindness of my friend, Dr. L. Neumeyer, of the Anatomical Institute in Munich.

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* To Professor Rückert's interesting paper I am indebted for a number of the present notes.

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RECENT PROGRESS IN GEODESY.*

This report is not based upon a complete examination of the recent literature of geodesy. The writer has been too busy to devote much time to the special research necessary to justify any claim to completeness. His regular duties have, however, kept him in touch with recent operations in geodesy, much more closely in touch, however, with operations in the United States than with those of Europe. The sketches of recent progress in each of several sciences called for by the rules of the Society are, as I conceive, to be written primarily, not for those well versed in that particular

*Forming a part of the Report of the Standing Committee on Mathematical Science for 1899. (Read before the Philosophical Society of Washington, February 3, 1900.)

science, but for the general information of others working on other lines. To this end a bird's-eye view of the present state of the particular science, together with a statement of the more important and interesting recent developments, will serve better than a detailed catalogue of the separate steps which make up recent progress.

By studying the recent reports of the International Geodetic Association and the geodetic reports from various countries, one is gradually convinced that there is well-sustained activity in geodetic operations in many countries, that geodetic facts are being steadily accumulated, and that steady progress is being made in improving methods and instruments. Having realized this, one naturally looks for published collections of results, and for some reasonably complete and well-digested scientific papers showing the relation between existing theories and results. One expects to find a considerable portion of the accumulated facts published in convenient form for the use of the hydrographer, topographer, the physicist, and the engineer. But this expectation is not realized. Of the great store of accumulated facts only a small part are as yet published in any complete or systematic way. The remaining ones are published, if at all, in such a fragmentary and disconnected form as to lose much of the value which they would otherwise have. Again, one looks in vain for any comprehensive study in recent years of the earth's figure and size. Since the publication by Colonel Clarke, some twenty years ago, of his values for the polar and equatorial radii, no corresponding comprehensive investigation has appeared in print.

It is not easy to understand why publication and discussion should lag so far behind the measures in the field. One consideration presents itself, however, as a partial, though insufficient, explanation. To adjust a network of triangulation requires an amount of expert computing which, as to time and cost, seems disproportionate to the field-work. Consequently, there is a decided tendency for the computations to be several years behind the corresponding field operations. By the time computations are finished for a given area new results of observations are available in that area or in adjacent connecting areas. Thus it always seems that the time for publication has not come, since whatever might be published would of necessity be incomplete.

It may be admitted that in many cases the computations made have been more complex and laborious than was warranted by the observations. The problem is one which lends itself to many theoretic refinements leading to long computations.

In what is above written as to delays in publication and computations needlessly prolix the writer must not be understood as referring chiefly to work in United States. Publication is apparently no further behind in this country than in other countries, with the possible exception of Great Britain. In simplifying the computations in office to correspond with the accuracy attained in the field, this country is easily foremost.

The years 1898 and 1899 mark an epoch in the history of geodesy in the United States. In 1898 the last of the field operations on the great transcontinental arc, extending from the Atlantic to the Pacific along the thirty-ninth parallel, were completed. During the same year the field measures of the oblique arc parallel to the Atlantic coast were also completed. In 1899 the necessary observations to complete an oblique arc in California, extending from Point Arena to the Mexican boundary, were brought to a close. In 1899 also, but little more than a year after the completion of the last field measurements, the computations connected with the arc of the thirty-ninth parallel were completed and the results put in form for the printer.

To appreciate the full force of the above statements one must have a realizing sense of the great length of the above arcs. The combined length of all the arcs used by Colonel Clarke in 1880 to deduce the figure of the earth was equivalent to 89 degrees of a great circle. The arc of the thirty-ninth parallel is equivalent in length to 37 degrees of a great circle; the Atlantic oblique arc is 22 degrees long, and the California oblique arc 8 degrees; and the combined length of these three arcs is 67 degrees, or more than two-thirds the total length used by Clarke.

The most interesting recent development in geodesy has been the investigations of variations of latitude. It may be asked, "Why is this investigation classed as geodetic rather than astronomic?" The answer is: It belongs in both classifications. Obviously it is an astronomical investigation, but it concerns the geodesist also; it concerns him directly, because the astronomical latitudes with which he must deal are now known to be a function of the time of observation. It is interesting to note also that many of the observations upon which our knowledge of the latitude variation depends were made with the zenith telescope, an instrument which the geodesist claims rather than the astronomer.

For ten years past there has been marked activity in investigating this question along two lines. One class of investigators worked by the inductive method, and slowly built up empirical mathematical expressions for the observed facts as to the variations, independently of any theory as to their causes. For this purpose they used many series of old observations, made at various fixed observatories, but not primarily for this purpose. In addition they have used many modern series of observations, made with zenith telescopes, for this special purpose. It has been shown that the motion of the pole in the past may be represented with considerable accuracy as a combination of two motions, each circular, one with a mean period of about 428 days and the other with a period of one year. A still closer approximation is obtained by assuming that the amplitude and epoch of each these motions is subject to a periodic variation. A somewhat closer agreement between the mathematical curves and the observations is secured when elliptical paths are substituted for the circular paths above referred to. The net result of the investigations by the inductive method has been certain mathematical expressions which closely represent the known facts of the past, but there is great uncertainty as to how far into the future these mathematical expressions may be extended, because their basis is wholly empirical.

The progress made along this empirical line of investigation has been due to Professor S. C. Chandler, of Harvard, more than to any other one man or, possibly, any group of men. His results have been published as the investigations proceeded in the *Astronomical Journal*, and form an exceedingly interesting series, not only on account of the remarkable success attained, but because of the ingenuity and skill shown in devising methods of investigation which are independent of any theoretical basis.

Another class of investigators has worked from the standpoint of pure theory. Their endeavor has been to furnish an adequate explanation for the observed facts. Up to the time when the latitude was shown, by direct observation, to be subject to periodic variations, one of the fundamental assumptions upon which astronomical computations were based was that the latitude of a given point on the earth's surface is invariable. Pure theory, indeed, indicated that the latitude of a point should be subject to a periodic variation of small amplitude with a period of about 305 days. Special investigations had failed to reveal a variation having that period, and astronomers had fallen back to the dogma of invariability. Theorists are now confronted with the necessity of accounting for a period of about 428 days instead of 305. It is known that any movements of the earth's crust and of the water and air in response to a displacement of the pole of figure from the pole of rotation have the effect of lengthening Euler's period. It has been shown that any difference in the equatorial radii also has a tendency to increase the theoretical period to correspond more nearly with the fact. The known atmospheric and oceanic currents have also been appealed to for an explanation. It has also been shown that it is not impossible that such impulsive forces as are concerned in earthquakes and volcanoes may produce some of the effects observed. The net result, however, of the investigations of theorists has been a series of partial explanations, no one of which stands all the tests which have been applied to it. Each fails, either by furnishing a law of motion which differs essentially from the observed facts or by being quantitatively inadequate.

This was the situation when the International Geodetic Association formulated and adopted a plan for determining the actual motion of the pole during a series of years with the highest attainable accuracy. The observations, in conformity with the plan devised by them, were actually begun in the latter part of 1899, and it is proposed to continue these observations uninterruptedly for at least five years. The plan of operations is that the actual motion of the pole shall be determined by simultaneous observations at four stations widely separated in longitude, at each of which an instrument of the highest precision is to be so used as to guard, as fully as possible, against all known sources of systematic error. The details of the plan have been worked out very carefully, and it is admirable in every respect.

The four stations selected are Gaithersburg, in Maryland, in longitude + 77; Ukiah, California, in longitude + 123; Mizusawa, in Japan, in longitude + 219, and Carloforte, on the small island of San Pietro, just west of Sardinia, in longitude + 351. One of these stations occurs in each of the four quadrants of longitude, reckoned from Greenwich. All are within three seconds of the parallel of 39° 8′ 10″. The conditions considered in selecting them, other than those indicated above, were that there should be nearly symmetrical conditions as to the character of the surface northward and southward of the station to avoid unsymmetrical refraction; that the hygienic, social, and climatic conditions should be such that the observer might remain healthy, comfortable, and contented; and finally in Japan and at the European station the region was carefully studied with reference to the probable frequency of earthquakes.

Two extra volunteer stations have now been added to these four, one at the Cincinnati observatory, which happens to be nearly on the parallel of the four selected stations, and one at Tschardjiu, in Turkestan.

The four principal observatories have been constructed with the utmost care, under specifications furnished by the International Geodetic Association, specifications designed to insure that observations shall not be vitiated by local differences of temperature. The observatory proper is surrounded by lattice-work to protect it from direct sunlight and the roof is double. During observations the roof is rolled back to leave an observing slit two meters wide. The walls are so low that the telescope projects above the roof during observations. This fact, together with the unusual width of the observing slit, puts the instrument virtually in the open air during observations.

The instruments used at the principal stations are specially designed zenith telescopes, by Wanschaff, of Berlin. The telescope has a focal length of about 51 inches, an aperture of $4\frac{1}{4}$ inches, and a magnifying power of 104. Aside from other minor peculiarities, two are especially noticeable. The barrel of the telescope proper is protected by an outer thin metallic tube, which is connected at but few points with the telescope proper, and serves merely to protect it against sudden changes of temperature. This false tube is pierced at various points to permit circulation of air in the space between it and the tube proper. The eyepiece is furnished with a reversing prism of peculiar construction, such that all observations may be made with the observing line apparently vertical and with the star apparently moving either upward or downward at the will of the observer. The observation upon one star consists of four pointings, two taken while the star is moving apparently upward in the field of view and two with the star moving apparently downward, the reversing prism being turned 180 degrees between these observations. If, then, the observer has a personal tendency to place the observing line too far to the right, this will have contrary effects in the two pairs of bisections, and the personal equation will be eliminated from the mean result. In so far as accidental errors are concerned, the few observations already made indicate a high degree of accuracy, the probable error of a single observation of a pair being about $\pm 0''.10$. Few series of observations yet made can show probable errors as small as $\pm 0''.16$.

The computed motion of the pole will be nearly independent of the errors in the assigned declinations of the stars, the effects of the errors of declinations being eliminated by the well-known group method. The stars to be observed are divided into twelve groups, and each group is observed for about two months (50 to 80 days, according to the time of year). During the first half of the period when group No. 2 is being observed group No. 1 is also being observed, and during the latter half of the period group No. 3 is being observed at the same time as group No. 2. Similarly, group No. 3 is observed first in connection with No. 2, and then in connection with group No. 4, and so on. The difference between the mean latitude from group No. 1 and the mean from group No. 2 during the period when both groups are being observed is obviously due to the difference of the mean error in declination of the stars of the two groups and to accidental errors of observation. This method of observation, after being extended throughout the whole cycle until group No. 12 overlaps group No. 1, furnishes a means of determining the declination correction to each group to reduce it to the mean of all the groups, and thus to eliminate the declination errors from the computed change in latitude.

As an additional precaution, the same list of stars is to be observed at all the stations.

The effect of an error in the assigned proper motions of the stars observed will be to make the latitude of any one station appear to increase or decrease with lapse of time, but will have no appreciable effect on the value finally derived for the motion of the pole; for, the same list being used at all stations, all the latitudes will appear to increase or decrease together. Both the Japan and the Maryland station, would appear, say, to have increasing latitudes, although they are nearly on opposite sides of the pole, and therefore this result could not be mistaken for an actual motion of the pole.

Aside from the precautions already indicated against abnormal refractions due to local conditions, the observations themselves have been planned so as to guard against errors arising from this cause. Each group contains six pairs which are used directly for computing the latitude variation, and of which very few have zenith distances exceeding 20 degrees. Each group also contains two pairs introduced for the special purpose of studying the actual refraction, and of which the zenith distance is about 60 degrees. The normal refraction at a zenith distance of 60 degrees is about four times that at 20 degrees; hence the two refraction pairs will furnish an effective method of determining any peculiarities of refraction which are sufficiently great to produce any appreciable effect upon the latitude pairs, provided such effect is one which increases with the zenith distance.

Any refraction effect which is analogous to a displacement of the apparent zenith, by a persistent barometric gradient, for example, will not be put in evidence by this test. To eliminate such an error, dependence is placed upon the fact that the final result is based upon observations at several stations varying greatly in longitude and in the surrounding climatic and local conditions.

It may seem at first sight that an annual variation in refraction would produce an apparent annual motion of the pole. This would be true if the motion of the pole were derived from observations at one station only. It will be seen, however, on further reflection that annual variations in refraction would tend to make all the latitudes along one parallel apparently increase and decrease together, and that therefore the computed motion of the pole would not be appreciably affected if these annual variations were of about the same magnitude at the different stations distributed around the pole.

To sum up, the discovery of the periodic motions of the pole was first made by a purely inductive method. The laws governing those motions have been slowly and painfully deduced by a continual application of the same method to old series of observations and to many new series made for the special purpose. Now a new campaign of observations, promising results more accurate than any hitherto obtained, has been commenced. The mean position of the pole for each fortnight of the next five years will probably be known within a radius of five feet. There is little prospect for improvement of the observational side of this question for many years. The new observations will furnish material for new triumphs of the inductive method in furnishing a still closer mathematical approximation to the unknown laws of motion of the pole. The interesting feature of this investigation is now that the theorists are at sea, so to speak. Will they at the end of the five years be able to furnish an adequate explanation for the new facts observed or, indeed, for those already known? It is on this theoretical side of the investigation that new energy is needed. Here is a golden opportunity for some one well versed in mechanics, astronomy, and geodesy.

JOHN FILLMORE HAYFORD.
U. S. COAST AND GEODETIC SURVEY.

*THE PLANKTON OF FRESH WATER LAKES.**

For some years I have been interested in the subject of the fauna of our fresh water lakes. This interest was first aroused in regard to the animals of the deeper parts of the lakes. The results of the explorations of the depths of the ocean were just becoming known. I had read in the older works that while the sea was densely populated along shore, and had what has become to be known as a 'pelagic' fauna and flora in the open sea, remote from land, the depths were a barren region utterly devoid of both animal and vegetable life. But later it had been shown that there was, even in the

* Address of the retiring President of the Wisconsin Academy of Sciences, Arts and Letters.

greatest depths, a fauna, not very abundant to be sure, but of great interest because of the strange peculiarities of some of the forms. With others I was profoundly interested in this work, and it lead me to conjecture whether there was not a field for investigation in the deeper waters of our lakes. At that time very little had been done in the way of any systematic study of the deeper waters of the lakes. I think the only extensive work on the subject was Forel's 'La faune profonde des lacs Suisses,' published in 1885. Professor Forel had begun his researches on the deep water fauna of Lake Leman in 1869, and had published various notices in the intervening years. In this country, so far as I know, the first publication in regard to the deep water fauna of lakes was in the first volume of the *Transactions of the Wisconsin Academy*, in a paper by Dr. Hoy, of Racine. He detailed how he had become interested in the food of the whitefish, and had examined their stomachs, finding certain animals that seemed new to science. A company was made up for a dredging expedition consisting of Dr. Hoy, Dr. Lapham, Professor Stimpson, Professor Andrews and Mr. Blatchford, and put in a day's work dredging on Lake Michigan in June, 1870. The result was the collection of a considerable number of animals. Especial importance was attached to the discovery of a *Triglopsis* and a *Mysis*, as they are marine genera, and their presence was supposed to indicate a former direct connection of Lake Michigan with the ocean.

In 1874 Professor Smith published a paper on the 'Invertebrate Fauna of Lake Superior,' reporting the existence of the same crustacea in Lake Superior which Dr. Hoy had found in Lake Michigan. The *Mysis* there, however, occurs in somewhat shallow water as well as in the greater depths. In both lakes it forms an important—perhaps the most important—constituent of the food of the white fish and lake trout. As I was located near a lake of considerable depth, a depth reputed to be anywhere between 400 feet and infinity, it occurred to me that I had an opportunity to carry out similar researches.

My own work on lakes, then, originated in a desire to know more about the abyssal animals. I soon found, however, that the problem was a serious and complicated one, involving a complete faunistic study of the lake. I was fortunate in finding on the bottom of Green Lake the same *Mysis*, which makes its home in Lake Michigan. These animals have not been definitely reported from any other lake in the United States, although *Mysis* is said to live in a lake in New York connected with the St. Lawrence. Here was a pretty problem in animal distribution. How did these animals make their way into Green Lake? Was it by way of the Great Lakes, or did they come at some time by a connection through the Mississippi Valley? I could not tell, and I cannot to-day, for it becomes a problem for the geologist rather than the zoologist. With this as a starting point I attacked the problem of lake faunæ, and the battle is still in progress with no indications of a conclusion of hostilities for many years to come.

During the decade in which I have been interested in limnology there has been a very considerable advance in our knowledge of the subject, and it will be my attempt to-night to summarize this knowledge, and make as clear a statement as I can in the brief time at my disposal of what is now known of the fauna and flora of fresh water lakes. Russell, in his work on North American Lakes, enumerates ten agencies which, acting separately or in combination, may produce lakes. So far as our Wisconsin lakes are concerned, the most important of these agencies is glacial action. Most of our lakes are simply the depressions caused by the unequal distribution of the glacial drift, or by interference with preëxisting drainage lines. Inasmuch as Wisconsin is not a mountainous state, it follows that these depressions are nowhere of great depth, and that we have no lakes which compare in depth with those located in mountainous regions. Most of our lakes are extremely shallow, few being more than forty or fifty feet in depth. Lake Geneva 142 feet, and Green Lake 237 feet, are our deepest bodies of water, while our largest lake, Lake Winnebago, probably does not exceed twenty-five feet. All lakes are temporary features of the topography. The outflowing water is all the time deepening the outlet and increasing the amount of drainage, while the inflowing water is bringing in material which gradually fills up the lake bed. This process goes on with comparative rapidity, and even in our new lake areas there are numerous examples of dead lakes where swamp vegetation entirely covers what was formerly an open sheet of water. The physical processes involved in the lives of lakes and the relation of the lake vegetation to these processes are very interesting, but this is not the time or place to discuss them, and they can only be referred to in passing.

The subject of the fauna of fresh water lakes has not been especially attractive to zoologists. This is but natural when we consider the great wealth of life in the ocean, and the comparative poverty of fresh water. Of the more important divisions of the animal kingdom the echinoderms and tunicates are entirely absent in fresh water, and the cœlenterates and molluscoidea are represented by few forms. Even the crustacea, which form the greater part of the plankton, and are present in such enormous numbers, have very few forms compared with the crustacea of the sea. It is to be expected that zoologists will be attracted by this wealth of material in the sea, and that most of them will in the future as in the past resort to the sea for their study. It was in the ocean that the ancestors of our fresh water animals dwelt, and it is amongst those animals that the student may expect to find the most information in regard to the development of life on the earth.

But the lakes have their fauna, a fauna of great numbers if not of great variety, and because of their isolation and somewhat peculiar conditions, present a very interesting study in the distribution of animals. Of course the best known members of this fauna are the fishes, whose numbers, habits, and food are fairly well known. Fish are so important for human food that a study of their habits comes to be a matter of commercial importance, and our Federal and State governments expend large sums of money for this investigation and for the practical work of rearing and distributing the spawn or young fish. In Wisconsin, too, as well as in some of the other northern States, it is a matter of great practical importance to maintain the numbers of game fish in our lakes simply for the purposes of sport. Until one has made the rounds of the summer resort lakes one has little idea of the multitudes of people who come to our State in the summer season, attracted largely by the opportunities for fishing. Hundreds of thousands of dollars are brought to us every summer in this way, and it is a good business policy which leads us to do all in our power, and even spend large sums of money, if necessary, to maintain our stocks of game fish.

It has long been known, of course, that fish are dependent for their food upon smaller animals, and it has also been known that a knowledge of these same small animals was necessary to any accurate and complete knowledge of fish, but this study was so difficult and involved so much drudgery that for a long time it was neglected.

Anything like an exact knowledge of the

crustacea may be said to date back only half a century to the writings of Fischer and Claus, although some papers upon this subject had been published previously.

In 1817 Say published a somewhat extended article on the crustacea of the United States, in which he speaks of one *Ostracod*, two *Daphnias* and one *Cyclops*, as inhabiting the waters of the southern states. In 1843, in the 'Natural History of New York,' was published an article by DeKay on the crustacea, which was beautifully illustrated, but added little to our knowledge of the fresh water crustacea. In fact, though *Cyclops* and *Daphnia* are mentioned, they are spoken of as 'extra-limital,' in spite of the fact that not a lake in New York would have failed to furnish him countless numbers of these genera, had he looked for them. To Professor Forbes, of the University of Illinois, is due the credit of making the first extensive collections of these animals in this country, and publishing accurate descriptions of them. His first paper was published in 1876, and was followed by a series of very valuable investigations, culminating within the last few years in the establishment of a floating laboratory on the Illinois River for the continued study of the fauna and flora of that river and the shallow lakes adjoining.

In Europe large numbers of investigators within the last few years have devoted themselves to the study of fresh water animals and plants. Preëminent among them have been Forel and his co-laborers on Lake Leman, and Zacharias and his fellow-workers in the station at Lake Plön in Holstein. This station at Plön was, I believe, the first permanent fresh water station in the world. Since its establishment in 1891, a considerable number of permanent stations have been established in various parts of the world. It is not my purpose here to give a history of these establishments, for that has already been exceedingly well done by Professor Ward. I may call attention in passing, however, to the fact that the work in this country has been done almost exclusively in our immediate vicinity, Illinois, Wisconsin and Michigan having published by far the most material on this subject. Similar work has been prosecuted in Minnesota, Ohio and Indiana, but very little has been done in the other states, if we except the exceedingly valuable work of Whipple.

In Wisconsin, work has been prosecuted on the Madison lakes and Green Lake for many years, and now, under the auspices of the Natural History Survey, a more extensive and systematic biological survey of the lakes is being made, probably a more extensive comparative study than has been attempted elsewhere. While this study is of especial scientific interest, as has been intimated before, it is of great practical interest in connection with the problems of fish culture. It may not be likely that, as suggested by a recent writer in *Forest and Stream*, the future angler will carry with him a thermometer and chart with a statement of the laws of vertical and horizontal distribution, but such study does give a fundamental knowledge which is of vast importance to the angler as well as to the fish culturist.

The terminology used in the study of the fauna and flora of fresh-water lakes, as in the sea, was formulated by Häckel. Under the term 'plankton' is included all living things, animal or vegetable, found in the water which do not move from place to place by their own volition. Fishes are not considered a part of the plankton. The life of the sea may be considered as 'littoral,' 'pelagic' and 'abyssal.' To these terms Häckel adds 'zonary,' to include those animals which are supposed to occur at zones of different depths in the open ocean. In the littoral and pelagic planktons we may have both animals and plants, but in the abyssal no plants are found. The study of the pelagic and abyssal faunas has been entirely within the last half century; in fact the very knowledge of their existence dates back hardly fifty years.

In the lakes we use a similar set of terms. The regions are 'littoral,' 'limnetic' and 'abyssal.' The characteristics of these regions are somewhat known, but still our knowledge is far from perfect.

A list of the plants and animals found in any one lake seems quite formidable because of its length, but the species that are present in any considerable numbers are very few. From a limnetic collection, for instance, we may find in abundance the following: Four or five copepods, five or six cladocera, three or four protozoa, and perhaps two rotifers. This would be a fair average fauna in one of our lakes. Of the plants, we would find two or three diatoms and as many algæ.

Not only are the animals and plants of neighboring lakes very much alike, but the same animals may be found distributed over wide territories, and even over different continents. This is true even of some of the higher animals of the plankton, like the crustacea. Of our fifteen species of *Cyclops* nine are found in Europe. In the case of one species it is not only found in Europe, but in Asia and in Africa, and literally does not vary a hair in these widely separated localities. On the other hand, the genus *Diaptomus* is very variable. We have not a single species which is common to the European lakes. Not only that, but there are many localized species in the United States. One species occurs, so far as known, only in a few lakes in the northern part of the lower peninsula of Michigan. A second is widely distributed in all the smaller lakes across the continent in the northern States. Another goes from the center of Wisconsin north into the Arctic regions. In the Rocky mountain regions are several peculiar species. Through the southern States two species are found which never come north. Mexico has at least one peculiar species. Of the other organisms, both animal and plant, most are world-wide in their distribution. From this fact of the general uniformity of fauna and flora over wide regions, it is clear that the study of a lake which simply produces a faunal and floral list is of very little value. There was a time when such lists were important, before this uniformity of distribution was determined, but that time is long since past, and those European authors who continue to fill the proceedings of learned societies with lists resulting from desultory explorations of one or more lakes are almost wasting printers' ink.

In the littoral region we find usually an abundant flora. Those plants which need an anchorage find it in the mud of the bottom, and the unattached plants are protected by those that are stationary. Protected by these plants and living upon them is an abundant fauna in which crustacea are the most prominent, although we find great numbers of rhizopods, infusoria, sponges, hydrozoa, worms, true insects and mites, mollusca and bryozoa. This abundance of the lower animals forms a rich supply of food upon which the higher animals can live. It is in this littoral region that the fish get the most of their food, and every fisherman knows that marshy borders are necessary to maintain the supply of fish. The animals of the littoral plankton are opaque, and generally are so colored that when they are at rest they are inconspicuous. Those that swim about and then drop to the bottom to rest are ordinarily so colored that they are not easily distinguished from the mud. Frequently in littoral regions the bottom is covered with a thick mat of *Chara*, which, in turn, forms hiding places for enormous numbers of the invertebrates.

The flora of the limnetic region can be, of course, only of floating plants. Among these are an enormous number of diatoms. *Chlorophyceæ* are present in larger or smaller numbers and sometimes large numbers of the *Cyanophyceæ*. Generally speaking the limnetic flora is not sufficiently abundant to attract attention, but on some lakes they are sometimes multiplied in such quantity as not only to attract attention but even to excite alarm. The surface of the lake has a thick coat of bright green, and as this is cast up on the shore by the waves it forms thick ridges which in their decay become very offensive. This phenomenon has been known in England as 'the breaking of the meres,' in Germany as the 'wasserblüthe,' and in this country as the 'working of the lakes.' The appearance is sometimes ascribed to the seeds of littoral plants. Only a few species of plants are concerned in this phenomenon, and the species differ somewhat in different lakes. Certain diatoms may be present, too, in sufficient numbers to produce an unpleasant 'fishy' smell in the water. This exaggerated growth of the limnetic flora is most pronounced in shallow or comparatively shallow lakes, and is frequently a source of great annoyance to cities which get their water supplies from such bodies.

The limnetic fauna, as I have said before in this address, has but few kinds of animals, by far the most numerous and characteristic being the crustacea. These are beautiful, transparent and nearly colorless creatures. It is not true, as is sometimes stated, that the limnetic fauna is entirely distinct from the littoral. The general character of the limnetic animals is certainly different, and distinctly different, from that of those found in the littoral region, but many individuals are common to both. It is true, however, that while there is hardly a radical distinction between the two faunæ, certain species are common in the limnetic regions and only rarely found in the littoral, while some that are everywhere in littoral collections are rarely found in those taken in the open water. There is, of course, no clear dividing line between the two regions, but one insensibly merges into the other, while, under the influence of the winds and waves, such limits as exist are continually changing.

In the species of crustacea there is a certain distinction between the limnetic fauna of the deeper lakes and that of the shallower. One species of *Diaptomus* is found everywhere in the Great Lakes, but in only three of the Wisconsin lakes—Lake Geneva, Green Lake, and Cedar Lake. The shallowest of these lakes—Cedar Lake—is about a hundred feet in depth. One of the species of *Cyclops* is very abundant in the Great Lakes, but is seldom found elsewhere except in comparatively deep lakes.

In a paper published in the Transactions of the Academy, I made the suggestion that lakes might be divided according to their faunæ into the deep water and the shallow water, suggesting as a possible limit between the two 40 meters. I have since found that Elhart Lake, 117 feet, and Cedar Lake, 95 feet, have many characteristics of the deep water fauna, and it is possible that the dividing line should be nearer 30 meters than 40.

The German authors make a distinction between 'plankton-poor' and 'plankton-rich' lakes, which very nearly corresponds to my deep-water and shallow-water lakes; for the total amount of plankton in the deep lakes is very much less than in the shallow lakes. This is easily explained. For the number of animals is, of course, dependent on the number of plants. Inasmuch as plants are dependent upon sunshine, they will grow in water only in those places that are reached by the sun's light. As the light of the sun penetrates in deep water only to a limited distance, the deeper parts of our lakes are entirely devoid of plant life. On the other hand in shallow lakes not only do we find the floating vegetation as in the deep lakes, but as the light reaches the bottom over a larger proportion of its surface, we have in addition a very large flora flourishing on the bottom. In some of the very shallow lakes nearly the whole bottom is covered with a rank vegetation. This is true, for instance, of Lake Vieux Desert. In Green Lake, on the other hand, inasmuch as the shores are somewhat precipitous, there is only a comparatively narrow margin on which can be supported a flora growing upon the bottom, while the larger part of the lake is so deep that only the floating vegetation can exist. It is easily seen, then, that a shallow lake will be 'plankton-rich' as compared with a deep lake. Fishermen recognize this fact, and expect the shallow lakes to be better for their sport.

It is evident, then, that the living limnetic vegetation must be at or near the surface, where it can have an abundance of light. Animal life, however, is not limited in this way. It was long ago shown that in the sea there was an abundant surface fauna and an abyssal fauna, but in regard to the condition of the intermediate region there has been some dispute. Agassiz has claimed that there is a region intermediate between the top and bottom, which is entirely devoid of life. This has been disputed by some authors, and late explorations seem to indicate that no region between the surface and bottom is entirely free from animals. A similar condition exists in the lakes. By far the most abundant fauna is at and near the surface, but animals are found in greater or less numbers at all depths. The larger part of the plankton is found within thirty or forty feet of the surface; but the same kinds of animals that form the fauna of the upper waters may be found at all depths, although in small numbers. *Limnocalanus* is an example of an animal which belongs to the intermediate regions. It, too, may be found in small numbers at any depth from the surface down, but it seldoms occurs in any considerable numbers outside the intermediate region.

Limnocalanus and *Daphnia pulicaria* are perhaps the only animals in fresh water which belong distinctively to the zonary plankton, although *Cyclops brevispinosus* is much more abundant between five and twenty meters than it is near the surface.

Collectors of plankton material have known that they could ordinarily make much more abundant collections at night than in the daytime. This has led to a belief that there is a vertical migration of the plankton, towards the surface at night, and away from it in the daytime. It was supposed that the whole body of the plankton moved up and down. This idea has been proved to be false. What movement there is is within quite narrow limits near the surface, and all members of the limnetic fauna do not, by any means, behave in the same way. They have most decided individual peculiarities, so that we cannot speak of the movements of the fauna as a whole, but each species must be considered by itself. Some of them do not move at all vertically, but have the same distribution from one end of the day to another. Others, like the larval forms of the copepods, are more numerous at the surface in the daytime than in the night. Some have a very pronounced migration. This is particularly true of *Leptodora* which is rarely found at the surface in the daytime, but appears at almost exactly forty-five minutes after sunset, remains at the surface during the night, and disappears again at just three-quarters of an hour before sunrise.

Most of the larger crustacea which form the great body of the plankton do migrate in this way, and it was natural, perhaps, to infer that the whole plankton moved up and down.

The limits of this vertical migration it is very difficult if not impossible to fix. Most of the movement is within one meter of the surface, the most marked changes being within one-half meter of the surface, and below three meters the amount of movement is very slight. Eight determining factors have been listed by Professor Birge as controlling the vertical distribution of crustacea: food, temperature, condition of the water in respect to dissolved oxygen and other substances, light, wind, gravity, age and specific peculiarities. Of these factors, by far the most important are food, temperature and light. Inasmuch as the food supply is controlled by temperature and light, we may speak of these two factors as, in the main, controlling the vertical distribution of the limnetic plankton. Of these two factors, temperature is the most important, although light has a marked effect on many species. In the winter season when the waters of all the lakes are very nearly uniform in their temperature from top to bottom, the vertical distribution of the limnetic fauna is much more uniform than in summer.

In the summer season the most marked changes in vertical distribution are correlated with the vertical changes in temperature. This is most distinctly seen in the deeper lakes. In these lakes it is a surface layer of greater or less depth which is warmed, the deeper layers feeling the effect of the summer's sun only very slightly. In Green Lake below 40 or 45 meters the temperature never rises above 6.11 degrees Centigrade, although the surface may run as high as 26.67 degrees C. In Lake Michigan the bottom temperature at depths of 360 feet is 4.2 degrees C., with a surface temperature of 18.3 C.

The change in the temperature from the top to the bottom is not a gradually decreasing one, however. A layer of water at the surface, which may be in midsummer some ten or twelve meters in depth, is very nearly uniform in temperature. From the lower surface of this layer there is a very rapid decrease in temperature for a short distance, and then a gradual decrease until a minimum is reached. This layer of sudden change in temperature is known as the 'thermocline,' and its position varies in depth with the season and the size of the lake. As the summer season progresses the thermocline grows lower. In the very shallow lakes the temperature during the summer season is nearly uniform through the whole depth. In Lake Winnebago, for example, there is seldom a difference between top and bottom temperatures greater than two degrees. In small lakes the thermocline is considerably higher than in large lakes. This is doubtless due to the influence of the winds, by which the small lake is less affected. This was very prettily illustrated in a comparison of the Waupaca lakes with Cedar Lake and Green Lake about August 1st of this last summer. In three of the Waupaca lakes—Rainbow, McCrossen and Beasley's, of which Rainbow is the largest and Beasley's the smallest, the thermocline was respectively at six meters, five meters and three meters. At the same time the thermocline of Cedar Lake was at eight meters, and the thermocline of Green Lake at eleven meters. The vertical distribution of the plankton has a very close relation to the thermocline, most of the animals being above it. *Limnocalanus*, *Daphnia longiremis* and *Daphnia pulicaria*, however, are found below the thermocline, and in some plankton-poor lakes the proportion of the other organisms below the thermocline is much larger.

It is evident that the circulation of the water is in the layer above the thermocline, and that below the thermocline there is insufficient oxygenation, and that this bottom layer must, too, hold a great deal of the dead and decaying material falling from the upper layers. It is a curious fact, first pointed out, I think, by Whipple, that the bottom waters of deep lakes are stagnant during both winter and summer, but have a period of overturning in spring and fall. This overturning may come with considerable suddenness when the waters have not been much agitated by the winds. We ordinarily think that water is so mobile that the heavier portions will immediately sink, and thus the water of greater density will always be at the bottom. It may happen, however, as in the fall, that the upper waters will cool off, and yet retain their position, so that the lighter water will actually be below. The lake is in a condition of unstable equilibrium. If, under these circumstances, there comes a heavy wind, the whole body of water will overturn.

It is at these two periods of overturning, as shown by Whipple, that the growth of diatoms is especially pronounced, and they are found present in enormous numbers in the limnetic plankton. This great growth of diatoms is explained in the following way: During the periods of stagnation diatoms or their spores, if diatom spores exist, accumulate at the bottom of the lake, inasmuch as their specific gravity is greater than that of water. They do not grow there, because sunlight is essential to their growth. At the bottom is accumulating during this period, too, a large amount of organic matter from the decay of organisms near the surface, and this, under the influence of bacteria, is transformed into material fitted for food for the diatoms: in this food material the nitrates are perhaps the most important. When the time of overturning comes, the diatoms or their spores rise to the surface, accompanied by these dissolved organic materials, and, under the influence of sunlight, an exceedingly rapid multiplication takes place. As the food materials are used up the numbers of diatoms decrease again. Other organisms, of course, show the effect of the overturning of the water, for many are directly or indirectly dependent upon the diatoms for food, and, besides, diatoms are not the only organisms which can make use of the food materials which are thus brought to the surface. *Diaptomus*, *Epischura*, *Limnocalanus* and two species of *Cyclops* show quite clearly these two periods of rapid production, although in some of these cases the results are complicated by the fact that the temperature of the surface water has a direct effect on the reproduction.

The matter of the annual distribution of the organisms of the plankton is a very interesting question, but is also a very complicated one. As has just been stated, certain of the diatoms have a distinct spring and fall maximum, and there are other organisms which, because of their dependence upon the diatoms, have similar periods of maximum growth. But there are other causes at work which control the growth of individual organisms, so that their optimum periods may come at very different times of the year.

Generally speaking it is probably true that the largest amount of plankton occurs in midsummer, although Yung says that the maximum development of plankton in Lake Leman is in May or June, and that the minimum is in March and September. Zacharias states that the maximum period for Lake Plön is about August 1st. Measurements of a large number of collections from various lakes in Wisconsin indicate that the maximum of plankton occurs in these lakes in the latter part of July. The exact period of maximum development may vary from year to year, and in different lakes, because of varying local conditions. The reason for this July maximum seems to be not because any considerable number of organisms have their highest development, but because of the fact that there is a greater variety of forms at this time than at any other time of the year. This is undoubtedly because of the peculiarly favoring conditions of temperature. It is this time of the year that seems to be especially favorable to the growth of the algæ. The 'water-bloom' may appear in June and remains sometimes until into September, but it is in July and August that it is present in the greatest quantity. This summer, on Lake Winnebago, it was most abundant during the latter half of August.

The minimum of plankton development is in the winter months, especially in January and February. At no time of the year, however, are either plant or animal forms wanting, and collections made through the ice will give a considerable variety of kinds, as well as numbers of individuals.

It will be noticed that the period of maximum plankton development corresponds to the time of highest temperature of the water, and that the period of minimum development corresponds to the time of lowest temperature, so that we can be certain that the one important controlling factor in the growth of plankton is the temperature.

Hensen and his co-laborers who worked out a very elaborate system of measuring the plankton of the sea claimed that the distribution of the plankton over wide stretches of the sea was nearly uniform. Granting this to be true, it evidently is possible by a series of collections and measurements to compare different parts of the ocean in regard to their productiveness in animal and plant life. This conclusion, that the horizontal plankton of the sea has a practically uniform distribution, has been accepted by the majority of scientists, although vigorously combated by Häckel.

Apstein has applied the same methods to the examination of lakes, and has concluded from his investigations that the plankton of lakes is uniformly distributed. It is easily seen that there is very good reason for assuming this to be the case from the actual conditions under which the plankton exists. The plankton consists of organisms that do not move voluntarily from place to place, and therefore do not change their positions. They are dependent upon heat and light for their development, so that their growth is mainly within from twenty to forty feet of the surface, so that a depth exceeding this would not mean any greater production of plankton—or in other words, the amount of plankton depends not upon depth, but upon surface.

This is a most important conclusion, if true, for it gives us an exact method by which we can compare one lake with another and determine their relative productiveness, or from a series of collections, determine the absolute annual productiveness of any body of water. Such determinations would have an important commercial value, for by them could be estimated the possibilities of fish production in a lake. The method was worked out in detail and very elaborately by Hensen. The collection was made by a conical net of bolting silk drawn vertically through the water, thus straining out the organisms of a column of water of the size of the opening of the net. Then the material was counted under the compound microscope by a very laborious process. In this way exact numerical values can be obtained not only for the plankton as a whole, but for the individual constituents. Most investigators use Hensen's methods with greater or less modifications, and they have been productive of very fruitful results. But, unfortunately—I say unfortunately, because we all like to claim exact results, and are prone to think that nature works according to certain inflexible laws—much of the laborious detail of the work is a waste of time.

The question of the uniformity of horizontal distribution has been discussed by various authors and with considerable vigor, but I think it must now be acknowledged, that while there is a certain amount of uniformity, so that, by a considerable number of collections, we can express within rather wide limits the amount of plankton at any time on a lake, uniformity in any exact sense does not exist. This lack of uniformity is largely due to a difference in the number of crustacea, although there are marked differences in the distribution of the other organisms. Surface growing plants, for instance, are moved about under the influence of the winds, and accumulate on the leeward side of a lake. If one part of a lake is deeper than another and the lake is not much disturbed by the winds, at the period of maximum growth the number of diatoms will be much greater over the deeper part. Crustacea may be in ill-defined aggregations which may be called swarms, and these swarms are not stationary in all cases, but move slowly, perhaps under the influence of extremely weak currents. Not only is there a considerable variation in collections made at different locations on a lake at the same time, but if a series of collections is made at the same place, the amount of the plankton in some collections may be twice as much as in others. An examination will show that these large variations are generally due to a difference in the numbers of some of the crustacea, showing conclusively that not only do the numbers of crustacea vary at different locations, but that these swarms are not stationary. It follows, then, that conclusions in regard to the plankton drawn from a few collections may be quite erroneous. If, however, a considerable number of collections is made, especially if they are made from widely-separated localities, the average of all these collections, allowing something of a margin for error, will give a fair idea of the amount of plankton in a lake. Of course, the larger the number of collections the less the amount of error, but anything like very exact results can not be expected. We are able, in this way, to compare the plankton of one lake with that of another, or to determine the relative amount of plankton at different times of the year on any single lake. But any estimate of the actual amount of plankton produced by a lake at any time or during the year must be acknowledged to be only an approximation. Care must be taken, too, in comparing one lake with another, that they be compared under similar conditions. The maximum of one lake may not be reached at the same period as that of another. The conditions of a deep lake are very different from those of a shallow lake, and a fair comparison can be made only by averaging collections continuing over a considerable period.

In the abyssal region, because of the lack of light, plant life is impossible, and the fauna is very meager.

It is true that the list of animals which have been found in the abyssal regions of lakes is a long one, including, as it does, protozoa, cœlenterata, worms, molluscs, bryozoa, crustacea, arachnida, insect larvæ, and some few fish, but an examination of any single lake shows that not only is the number of kinds small, but the numbers of individuals of any kind are very small. In Europe the abyssal fauna of Lake Leman has been worked up with great thoroughness. In this country very little detailed work has been done on this subject. It is not a fruitful field for research, and it is not strange that it has been neglected. In shallow lakes it is doubtful if there is any distinctive abyssal fauna. The most abundant animals in the mud of the bottom are worms, insect larvæ, gasteropod and lamellibranch molluscs, and amphipods. With these may be associated at times great numbers of other animals, as occasionally one finds in the mud of shallow lakes large numbers of fresh-water hydra. Most if not all these animals are identical with the littoral forms, and the difference between the littoral fauna and the deep-water fauna is that in the deep water those forms which are especially dependent upon the weeds for food and protection are lacking, while we find in abundance the mud dwellers.

In the abyssal regions of deep lakes, however, we find forms which are characteristic of those regions, although they may be mingled with others that are also found in the littoral region. In the abyssal region of Green Lake, which may be considered the typical deep-water lake of Wisconsin, are found, besides some undetermined worms, a little lamellibranch, *Pisidium*, ostracods, amphipods, insect larvæ and *Mysis*. There are some protozoa in the mud, but they have not been studied. The ostracods are so numerous that their shells form a conspicuous part of the bottom deposit.

In the smaller lakes of a depth ranging from 60 to 100 feet, like the Waupaca lakes and Elkhart, a different condition of things exists. The bottom is composed of a dark mud, and is almost completely devoid of life. This has been a puzzling fact, and has been to me personally a matter of considerable disappointment because of my interest in abyssal animals. The probable explanation seems to be that these depths are rendered unfit for life by reason of the more complete stagnation of the deep water in small lakes, and because of the larger amount of organic matter which is being decomposed there. Because of the small areas of such lakes, leaves are carried from the shore all over their surfaces, and, sinking to the bottom, increase largely the amount of decaying organic matter. Partly decomposed leaves are common in the bottom collections of small lakes but rare in lakes of the size of Green Lake or Lake Geneva. This may account largely for the black color of the bottom mud. Then, in a large lake, the winds indirectly produce slow bottom currents. A prevailing wind will pile up the water at the end of a lake; this water must return in some way, and there is good reason to think that at least a part of it returns by a slow bottom current. Professor Birge tells me that his temperature observations give evidence of such a movement of the water. It follows, probably, that in the large lake there is not perfect stagnation, and hence the conditions of the bottom are more favorable for animals than in a small lake. The larger the lake, then, other conditions being equal, the greater would be the abundance of abyssal life. While there have been no accurate means of comparing the abyssal fauna of the Great Lakes with that of the smaller lakes as to quantity, such collections as have been made would indicate that it is much greater in the Great Lakes, and decreases in proportion to the degree of stagnation. If my explanation proves to be the correct one, as I feel quite certain it will, it will follow that the small deep lake will be limited in its fauna in two ways: because of its steep shores it will have a small littoral fauna and flora, and because of its stagnant deep water it will have little or no abyssal fauna.

I have thus far spoken as though all lakes had the three faunæ: littoral, limnetic, and abyssal. Generally speaking this is true, even small bodies of water showing this distinction. But occasionally the distinction is almost lost. This is true in Lake Winnebago. In spite of its great size—the lake is some twenty-eight miles long by ten or twelve broad at its greatest width—it is only about twenty-five feet deep. In its fauna there is a curious mingling of littoral and limnetic forms, littoral forms being found in the open lake, and limnetic forms even among the weeds along shore. The explanation seems to be this: because of its slight depth the environment, even far from shore, is favorable to the growth of littoral forms. Then there is good reason for thinking that the winds have a profound effect on its waters, thus thoroughly mixing limnetic and littoral waters, and consequently causing a similar mingling of the organisms. Lake Winnebago has the characteristics, in many respects, of an enormously overgrown puddle. I do not say this, however, to show a lack of respect for this lake, for from a practical standpoint it is a most valuable possession to the state. It can support, and does support, an enormous number of fish. Few lakes can compare with it in productiveness.

All the inhabitants of fresh water are, of course, descendants of marine forms. In some cases the modifications have been very great but in others they are hardly to be distinguished from their salt-water relatives. This is true, as has already been stated, of some of the crustacea: in some of these it is difficult to make a specific distinction between the fresh-water and marine forms. Most of the environmental conditions in fresh water are so different, however, from those in the sea, that we should expect a fauna to develop itself which would differ widely from its ancestors.

It will be noticed that the most pronounced likeness to marine animals, perhaps, is found in the abyssal forms. So far as that is true, it may be explained, I think, by the uniformity of conditions existing in the depths of lakes. The temperature varies but a few degrees from one end of the year to another, and such currents as exist are slow and almost imperceptible. The abyssal fauna of a lake is subject to nearly the same conditions as that of the sea, except for the difference in the composition of the water. If, as has been supposed, the deep-water fauna of the Scandinavian lakes is descended directly from the deep-water fauna of the sea, coming from the sea into lakes having a communication with salt water, and surviving there after the lakes were cut off from the sea, and their waters had become fresh, we can see how the animals could gradually adapt themselves to their surroundings, inasmuch as the conditions of light, temperature and food supply would remain with very little change.

With the limnetic and littoral fauna, however, a very different condition exists. In our climate the temperature of the surface varies during the year from the freezing point to eighty degrees or more Fahrenheit. In shallow lakes, not only is there this variation of the surface, but the lake may be frozen to the bottom in winter, so that all forms which can not go into a resting stage of some kind are destroyed. The conditions of life are hard, and especial fitness is required in order to make survival possible. In the sea, on the other hand, the conditions even of the littoral and pelagic fauna and flora are much more uniform. It is not strange that the fresh-water animals and plants are of few kinds, and that generally they are very different from those of the sea. It is perhaps more strange that so many resemblances remain, and that the forms are so varied as they are.

To trace out the connection of the individual forms with their marine ancestors is, of course, the work of the specialists in zoology and botany. It may be noticed, however, that the present population of our lakes has come since the glacial period, in fact the lakes themselves only date from that period. So far, then, as the fauna and flora pass from one body of water directly to another, we may assume that the present animals and plants are descended from those that were pushed south by the ice, and that as the ice retreated they followed again towards the north.

Currents carry organisms from one part of a lake to another, and from one lake to another by connecting streams: in this way animals or plants introduced at the source of a river may be carried through its whole length.

From lake to lake, too, seeds, eggs and living animals are carried by water fowl attached to their feathers or in the mud upon their feet. This is not simply from one lake to its neighbor, but many of these birds take long flights before alighting, so that the organisms are scattered over a wide stretch of territory. It is in this way, probably, that we can account for the uniformity in the fauna and flora of the lakes and the wide distribution of some of the forms. Where conditions are similar, then, we may expect likeness in the fauna and flora. As we have seen already, temperature is the great controlling factor in distribution, so that in lakes of the same latitude or the same elevation, other conditions being equal, of which the principal is depth, we may expect close similarity in fauna and flora.

We may assume, then, that the littoral fauna and flora have had their origin from neighboring bodies of water, and that as the ice retreated, the lakes were populated, partly by direct migration between contiguous bodies of water, and partly by the aid of the winds, currents and water fowls The limnetic fauna and flora is descended either from littoral forms which have gradually adapted themselves to limnetic conditions, or from pelagic forms, which, in bays where the water was less salt or brackish, have become adapted to the conditions of fresh water and have been distributed by the same agencies as the littoral forms.

Part of the abyssal fauna is descended from marine forms directly, as in the 'fauna relicta' of the Scandinavian lakes, and in the case of some of the animals in our Great Lakes. Another part of the abyssal fauna is descended from littoral forms which have gradually moved into deep water, and have been modified to suit their new environment. All the abyssal fauna of the Swiss lakes is supposed to be of this character.

What I have said thus far applies almost exclusively to lakes of the temperate zones, for it is there that lakes exist in the greatest numbers, and it is upon such lakes that most of the work of investigation has been done. But there are lakes in warmer climates, and we may expect that a thorough study of them will give us much that is new and interesting. A striking example of the extraordinary interest that may be attached to such lakes is Lake Tanganyika in Africa. Some years ago it was reported that a jelly fish was abundant in its waters. This excited the curiosity of zoologists, for the medusa is a marine form, and very rarely is found in fresh water, the most noted case being of the one found in the basin in Regent's Park, which is supposed to have been brought with plants from some tropical country. The *medusa* of Tanganyika is one of four jelly fish known to live in fresh water, and the other examples are very rare. A special expedition was organized to make an exploration of Lake Tanganyika, and although this work was very imperfectly done, the results appear to be of great interest. Along with the ordinary lacustrine fresh-water fauna there is a fauna of marine origin, but this marine fauna is not closely related to modern forms. It does, apparently, closely resemble Jurassic forms. Indeed, it is said that were some of the forms referred to a paleontologist, he would not hesitate to say that they belonged to Jurassic times. Have we here, then, a 'fauna relicta' which dates back to Jurassic times? It is too early to answer this question with any certainty, both because of our imperfect knowledge of the fauna of Lake Tanganyika, and because of our great ignorance of the geology of that part of Africa. But the mere possibility that this may be true is startling, and should incite scientists to a thorough study of the fauna and flora of Lake Tanganyika and the other lakes of Central Africa. So far as explorations have gone this 'halolimnic' fauna as it has been named, is peculiar to Lake Tanganyika, but we may expect to find more or less of it in other lakes.

A few words in regard to the work on plankton which remains for the future investigator. It will, I think, be evident, that so far as exact and comprehensive knowledge is concerned, we have but entered a vast field. We know so little, that we can say that we are just beginning to place limits on our ignorance.

A systematic knowledge of the fauna and flora is a first and fundamental condition of comparative biological work. We need accessible manuals by which the animals and plants dealt with can be identified. Systematic work may not be the highest or the most satisfying to the investigator, but it is very necessary. The plankton student is met, at the very beginning of his work, with a difficulty that is almost a complete block to further progress; although the number of forms with which he has to deal in his plankton work may be very few, he has to have the knowledge of a specialist in each group in order to identify them. If a laboratory has a company of specialists, the material is quickly identified by passing from one to another. But if the investigator is by himself, he finds himself in a most discouraging situation. The literature of the various groups is scattered and fragmentary, and frequently is utterly useless to any one but a specialist. There is need of a manual, or rather a series of manuals, that shall so treat of the fresh water fauna and flora, that any well-trained biologist shall have no difficulty in identifying his material outside the group which he may have made his special study.

It seems to me that we have nearly reached the time when the publication of such a manual should be possible. Most of the preliminary work has been done. More, perhaps, remains to be done on the botanical side than on the side of zoology, for the exact study of the lower aquatic flora has been much neglected. I hope that the time is not far distant when we may have such a manual produced in this country, with the coöperation of our best specialists. Nothing would do more to further the study of plankton, for it would furnish the student with a tool of inestimable value.

In regard to the plankton itself, very little is really known of the abyssal fauna and its controlling conditions. I have spoken of the fouling of the water at the periods of stagnation, but our knowledge of the conditions of the water at those times is very imperfect. There should be a systematic examination, by chemical analysis of the water and its contained gases, and of the mud of the bottom, and an exact comparison should be made between the lakes with sterile bottom waters and those with a comparatively abundant fauna. In connection with this should be a study of the currents of the abyssal region. A more careful and thorough examination should be made of those lakes whose geological history indicates that they were formerly connected with the sea, and may contain a 'fauna relicta.' I may say that it is not likely that such explorations will yield any startling results. The time for that is probably past, and the lake student of the future must content himself with hard work, without the satisfaction of brilliant discoveries.

Our quantitative knowledge of plankton is only a beginning. We know something of the conditions on a few lakes, but only on a few, and we do not know what variations may be caused by the peculiarities of individual lakes. Even in the same lake the conditions may change from year to year, and in only a few instances have observations continued through a series of years. We are all prone to generalize on the facts in our hands, but it must be acknowledged that the facts upon which we can build theories of fresh water plankton are very meager. There is need of a series of examinations of typical lakes carried on for a term of years, before we can build with certainty.

There remains the great problem, or complex of problems, of the relation of the different elements of the plankton to each other and to the fish. We see, frequently, an apparent overproduction of one of the elements. In shallow lakes—at least in many of them—there is apparently a great overproduction of vegetation. How is this explained? How is the balance of life restored? What constitutes an ideal relation between the vegetable and animal growth? When we plant a new species of fish in a lake, we, of course, disturb the existing balance of organisms, may we not, in some cases, at least, work actual damage? To what extent is this balance between animals and plants maintained in a lake that is not interfered with by man?

These and similar questions, now without answers, offer a field of almost unlimited work, and work that is worthy the best efforts of our students. For while my address, in treating of the present condition of the study of lakes, has dealt largely with isolated facts, after all it is not the facts which the student pursues as his ultimate aim, but the general laws underlying the facts. He is an unfortunate man who sees the trees, but cannot perceive the forest, who can see the stones of which the cathedral is constructed, and show how they were lifted to their places, but cannot perceive the beauty of the structure as it stands in its exquisite proportions, its massive masonry and wealth of sculptured detail only serving to express the idea of beauty and harmony in the master mind of the architect.

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SCIENTIFIC BOOKS.

The Cambridge Natural History. By DAVID SHARP, M.A. (Cantab.), M.B. (Edinb.), F.R.S. Vol. VI. *Insects* (Part II.). London and New York, Macmillan & Co. 1899. 8°. Pp. xii+626, and 293 cuts.

The completion of that portion of the Cambridge Natural History which is devoted to insects is an event of unusual importance to entomologists; for these two volumes constitute the most useful work of its kind that has appeared since the publication of Westwood's Classification of Insects.

The most striking feature of this work is the same as that which characterized Westwood's Classification and has made it an indispensable part of every entomological library; that is, it includes the results of a careful sifting of the greater part of all entomological literature. In a word, these two volumes of the Cambridge Natural History constitute an encyclopædia of entomology, written by one who has thoroughly studied the more important contributions to all departments of entomology, and who also contributes much that is new.

An admirable feature of the work is the fact that it is well-balanced; the morphology, the taxonomy, and the œcology of insects have each received sufficiently full treatment. The student of any phase of entomology is almost sure to find someting on his subject here and to find also references to the more important literature.

The author has placed entomologists under so great obligations to him that one does not feel like saying anything but praise of his work. I cannot help feeling, however, that it would have been better if in some respects he had been less conservative. This is especially true of his treatment of the larger divisions of the class of Insecta; his conclusions on this subject are hardly an advance on what might have been written a quarter of a century ago. In fact this is the weakest part of his work. Thus, in his discussion of Brauer's classification (Vol. V., pp. 175–176), he has apparently failed to grasp the most important point brought out by Brauer. He says (p. 175) that one of the chief characters on which Brauer bases his system is the existence or absence of wings ; and later (p. 176) he says "Thus it (Brauer's classification) begins by a division of Insecta into winged and wingless ; but the winged division is made to comprehend an enormous number of wingless Insects, whole subdivisions of Orders such as Mallophaga being placed in the winged series, although all are without wings." Now the fact is Brauer does not use the existence or absence of wings as a character distinguishing the two groups into which he divides the Insecta. Brauer believes that the wingless condition of the Thysanura and Collembola is due to their generalized condition ; that none of their ancestors had wings. On the other hand he believes that the wingless condition of all other wingless insects is a secondary condition, that they have descended from winged ancestors. In other words that existing insects represent two distinct lines of descent ; in one, the primitive wingless condition has been constantly retained ; in the other are found only descendants of a common-winged ancestor. This distinction is clearly indicated by the names he proposed for the two groups, Apterygogenea and Pterygogenea. The fact that many of the Pterygogenea have lost their wings does not militate in the least against this distinction. The only indication that our author has understood Brauer's position is a statement that "This first division is entirely theoretical." But if we give him credit for understanding Brauer we must blame him for stating the case in a very misleading manner.

As a rule, however, the work is written in a clear, simple style. The illustrations are abundant and are excellent ; and the pages present an attractive appearance. It is a work that no entomologist can afford to be without.

J. H. Comstock.

Traité de Zoologie Concrète. By Yves Delage and Edgard Hérouard. Tome 11, 1re Partie, Mésozoaires, Spongiares. Paris, Schleicher Frères. 244 pages 15 colored plates and 274 text figures. 1899.

In the most recent volume of their 'Concrète Zoology' Delage and Hérouard present, from the teacher's standpoint, one of the most difficult branches of Invertebrate Zoology, and only praise is due them for the excellent manner in which the subjects are treated.

The group including the two families Dicyemidæ and Orthonectidæ, to which Van Beneden gave the name Mesozoa as indicative of their supposed intermediate position between the Metazoa and the Protozoa is considerably enlarged by the addition of a number of forms which show less evidence of degeneration than do Van Beneden's original types. The classification, however, is only provisional, for in most cases the life history is not known and it is recognized that future investigations may show the forms in question to be only larval stages of other animals. With this in mind the authors make four classes of the Mesozoa as follows, the name of each class indicating the nature of the sub-ectodermal structures : (1) Mesocoelia.—Forms having a digestive cavity with no other cellular boundary than the ectoderm (Frenzel's *Salinella salve*). (2) Mesenchymia.—Forms having a parenchymatous tissue within the ectoderm and without a digestive cavity (*Trichoplax* and *Treptoplax* (Monticelli)). (3) Mesogonia.—Forms without digestive cavity and with one or several cells beneath the ectoderm which are destined for sexual reproduction (Dicyemidæ and Orthonectidæ). (4) Mesogastria.—Forms having a digestive tract like the archenteron of a gastrula, the walls being separated from the ectoderm by a coelomic cavity in which there is no intermediate tissue (*Pemmatodiscus*, a parasite on *Rhizostoma pulmo* (Monticelli)). In addition to these classes, Haeckel's Physemaria, the 'urn' forms in the cavities of the Sipunculidæ, and the curious form described by Caullery and Mesnil under the name *Siedleckia nematoides*, are included as appendices.

In the second part of the volume the authors put into their subject an intimate knowledge gained only by personal investigation and continued research upon the structure and the development of the Sponges. The result is a clear and concise presentation of the numerous complicated Sponge-structures. The canals, inhalent and exhalent, with their many confusing branches and chambers, are admirably portrayed and their mode of origin from the simple condition of an hypothetical rhagon-type is clearly shown. The spicules have received especial attention and the confusing nomenclature is presented in a table where ninety-eight different types of spicules are described and named in accordance with the views of Sollas, Lendenfeld, Stewart, and Schultze. With only eight exceptions a figure of the spicule accompanies each description and with this table, an average student for the first time, can classify Sponges while the admirable schematic figures of the organisms will help him to understand their structure.

The Sponges are divided as usual into two branches, CALCARIA and INCALCARIA. The former is subdivided into two orders, Homocœlida and Heterocoelida (both adapted from Poléjaef); the latter is further divided into two sub-classes, Triaxoniæ (F. E. Schultze) and Demospongiæ (Sollas). The first sub-class includes two orders, Hexactinellida (Zittel, Lendenfeld) and Hexaceratida (adapted from Lendenfeld); the second sub-class includes three orders, Tetractinellida (Marshall) Monaxonida (Ridley and Dendy) and Monoceratida (Lendenfeld). The further divisions are made in accordance with the nature and disposal of the spicules. An improvement in the editing of the volume, although of minor importance, is noted in the presence of the name of the family to which the various genera belong and this cannot fail to help the student.

As with the previous volumes disputed questions are clearly stated and the arguments on both sides are fairly presented, the authors in most cases taking a decided stand upon one side or the other. If a critic wished to hunt for defects in the work he might be successful in the section which treats of the physiology of nutrition; this portion of the volume is not complete enough.

In connection with the taxonomic position of the Sponges, the authors maintain with Hatschek, Perrier and Parker and Haswell that they represent a phylum entirely distinct from all other types. In their opinion one character is sufficient to justify separation from the Coelenterata and from all other groups. This feature is the fact first made out by Delage, that the germ layer which corresponds to the ectoderm of other Metazoa, passes during gastrulation to the interior, where it forms the choanocytes in the walls of the ciliated chambers, while the endoderm layer becomes superficial and forms the definitive external covering. They also state that ontogeny throws no light at all upon the relationships of the group.

GARY N. CALKINS.
DEPARTMENT OF ZOOLOGY,
COLUMBIA UNIVERSITY.

A Memoir on the Palæzoic Reticulate Sponges constituting the family Dictyospongidæ. By JAMES HALL in collaboration with JOHN M. CLARKE. (Memoir II, State Museum New York, 1898 [October, 1899], pp. 350, plates I–LXX, royal 4to. A portion of this work also appeared simultaneously with the same title, in the Fifteenth Annual Report of the State Geologist for the year 1895, Vol. II, pp. 743–984, plates 1–47.)

This volume is practically a continuation of the 'Paleontology of New York,' and had its inception in 1884. In 1890, but 42 species of *Dictyospongidæ* were known, and there are now described and figured all the paleozoic representatives of the living 'glass sponges,' of which there are 128 species. "This wonderful increase is not especially a matter for congratulation, save that it serves to show the amazing diversity of these silicious sponges in late Devonian and early Carboniferous faunas." All but 6 species are American. When the fact is noted that most collections contain but few specimens of these sponges, it is a surprise to learn that 70 species alone are found in the Upper Devonic of New York and Pennsylvania. It is mainly in New York that the great fossil 'sponge plantations' occur, and these have been and continue to be worked by Mr. Edwin B. Hall of Wellsville, to whom belongs the credit of having by far the largest collection of these extinct forms. From some of the New York localities several hundred specimens of a kind have been taken, but usually a single species is found in each or this may be even restricted to one colony.

Conrad (1842), was the first to record these fossils, regarding his *Hydnoceras* as a cephalopod. In the same year Vanuxem described another form, *Uphantænia*, as a plant, and this was the current interpretation for all the *Dictyospongidæ* until 1881, when Whitfield, from Lower Carbonic material, determined that they were the remains of sponges. Nearly all these fossils are found in sandstone, while the living *Euplectellas* are commonly anchored on muddy bottoms.

The present monograph begins with 'General Observations on the Sponges.' These are followed by sections on the affinities, structure of the skeleton, preservation, and occurrence, of the *Dictyospongidæ*. A detailed review of the bibliography, in which there are 42 entries, is next given, and then come a classification and the descriptions of genera and species. The family *Dictyospongidæ* is here divided into seven sub-families, all new. These are: *Dictyospongiinæ*, *Thysanodictyinæ*, *Calathospongiinæ*, *Physospongiinæ*, *Hyphantæniiæ*, *Hallodictyinæ*, and *Aglithodictyinæ*. Of new genera there are *Dictyospongia*, *Hydriodictya*, *Prismodictya*, *Gonglospongia*, *Botryodictya*, *Tylodictya*, *Helicodictya*, *Rhabdosispongia*, *Ceratodictya*, *Lebedictya*, *Thysanodictya*, *Arystidictya*, *Aclœodictya* *Griphodictya*, *Calathospongia*, *Clepsydrospongia*, *Roemerispongia*, *Hallodictya* and *Aglithodictya*. *Mastodictya* is another new genus, but is undefined. *Sphærodictya* is proposed to replace in part *Teganium* Rauff, which seems to include heterogeneous material. *Cyathophycus* is considered objectionable, because the name indicates a plant. On this ground Dawson changed it to *Cyathospongia*, a name used earlier by Hall. In this volume, the latter term is replaced by *Cyathodictya*. It is a question whether anything is gained by these changes (*Cyathophycus* to *Cyathodictya*, and *Uphantænia* to *Hyphantænia*).

Hydnoceras Conrad was proposed for 'an extravagant type of orthoceran cephaloped.' This, however, never came into use and is here revived 'not because it was founded on a misconception, but because it perpetuates one' (*sic*). On the other hand *Dictyophyton* was introduced by Hall in 1863, 'at the request of Mr. Conrad * * * to replace the term *Hydnoceras*.' The genotype is *D. newberryi*, which was also accepted for *Thamnodictya* in 1884. Under the rules of nomenclature such changes are not usually permissible, but since *Dictyophyton* 'tends to perpetuate the old and erroneous conception of the algous nature of these fossils' the name may be allowed.

The paleontology of New York serves as the highest expression of the work on American invertebrates, not only from a scientific standpoint, but also in artistic appearance. This volume on the sponges continues the previous standard, in spite of the fact that the preservation of the extinct glass sponges does not permit of much detailed elaboration. From an artistic standpoint, the present monograph is equalled by no other, not even by the elaborate 'Systeme Silurien du Centre de la Boheme' of Barrande. Professor Hall long ago recognized the accurate and artistic draughtsmanship of Mr. George B. Simpson and the ability of Mr. Philip Ast in lithographic work. Few can appreciate the skill and patience of the latter in overcoming technical difficulties. For 50 years New York has nobly supported her workers in pure science, and paleontologists look to that Commonwealth and to Dr. Clarke for a continuance of the splendid series of volumes on the paleontology of the State.

Charles Schuchert.

BOOKS RECEIVED.

The International Geography, by seventy authors. Edited by Hugh Robert Mill. New York, D. Appleton & Co. 1900. Pp. xx + 1088. $3.50.

Jenaer Glas und seine Verwendung in Wissenschaft und Technik. H. Hovestadt. Jena, Fischer. 1900. Pp. xii + 429. 9 Mark.

The Criminal. August Drähms, with an introduction by Cesare Lombroso. New York and London. The Macmillan Company. 1900. Pp. xiv + 402. $2.00.

Municipal Government. Bird S. Coler. New York, D. Appleton & Co. 1900. Pp. ix + 200.

Man and his Ancestor. Charles Morris. New York and London. The Macmillan Co. Pp. vi + 238. $1.25.

SCIENTIFIC JOURNALS AND ARTICLES.

The January number (Vol. I., No. 1) of the *Transactions* of the American Mathematical Society contains the following articles: 'Conics and cubics connected with a plane cubic by certain covariant relations,' by H. S. White; 'Formentheoretische Entwickelung der in Herrn White's Abhandlung über Curven dritter Ordnung enthaltenen Sätze,' by P. Gordan; 'Sur la définition générale des fonctions analytiques, d'après Cauchy,' by E. Goursat; 'On a class of particular solutions of the problem of four bodies,' by F. R. Moulton; 'Definition of the Abelian, the two hypoabelian, and related linear groups as quotient-groups of the groups of isomorphisms of certain elementary groups,' by L. E. Dickson; 'Note on the unilateral surface of Moebius,' by H. Maschke; 'On regular singular points of linear differential equations of the second order whose coefficients are not necessarily analytic,' by M. Bôcher; 'The elliptic sigma-functions considered as a special case of the hyper-elliptic sigma-functions,' by O. Bolza; 'On the groups which are the direct products of two subgroups,' by G. A Miller; 'On certain crinkly curves,' by E. H. Moore; 'A new definition of the general Abelian linear group,' by L. E. Dickson.

THE February number of the *Bulletin* of the American Mathematical Society contains the following articles: Report of the annual meeting of the Society, by the Secretary; a report of the December meeting of the Chicago Section, by Professor T. F. Holgate; 'On cyclical quartic surfaces in spaces of n dimensions,' by Dr. Virgil Snyder; 'On the singular transformations of groups generated by infinitesimal transformations,' by Professor Henry Taber; 'Proof of the existence of the Galois field of order p^r for every integer r and prime number p,' by Professor L. E. Dickson; a review of Méray's Infinitesimal analysis, by Professor E. Lovett; 'Notes'; and 'New Publications.'

THE contents of the March number of the *American Journal of Science* are as follows:

'Hot Water and Soft Glass in their Thermodynamic Relations,' by C. Barus.

'Conrad's Types of Syrian Fossils,' by C. E. Beecher.

'Electrical Thermostat,' by W. Duane and C. A. Lory.

'Toxic Action of a Series of Acids and of their Sodium Salts on Lupinous Albus,' by R. H. True.

'Explorations of the *Albatross* in the Pacific,' by A. Agassiz.

'Ægirite Granite from Miask, Ural Mountains,' by L. V. Pirsson.

'Illinois Gulch Meteorite,' by H. L. Preston.

'Silurian-Devonian boundary in North America,' by H. S. Williams.

SOCIETIES AND ACADEMIES.

THE ANNUAL MEETING OF THE NEW YORK ACADEMY OF SCIENCES, FEBRUARY 26, 1900.

PROFESSOR HENRY F. OSBORN, President of the Academy, opened the meeting with a brief address in which he spoke particularly of the needs of the Academy in reference to a permanent home, and a larger publication fund; of the work of the sections of the Academy, particularly of that of the Section of Anthropology and Psychology, in association with the recently organized Ethnological Society; and of the Section of Astronomy and Physics, which has lately added Chemistry to its field of operations. Professor Osborn paid brief tribute to certain of our distinguished Honorary members who have died during the year, particularly to Professor Bunsen, Dr. Geinitz, Sir William Dawson, and Sir William Flower.

The Recording Secretary reported a total of 333 resident members, and analyzed the 82 papers given before the Academy during the last year, as to their subjects, showing that the largest attention has been given to anthropology, astronomy, geology, paleontology, petrography, physics, and zoology. The Recording Secretary also reported that the annual reception and exhibition which was held in April, in the American Museum of Natural History, was, like its predecessors, extremely successful. For the first time since the reception has been held in the American Museum it was possible to have an unoccupied room, whereby there was no confusion between the Academy and Museum exhibits. The same plan will be followed during the coming year. The Academy feels that it owes a great deal to the President and Trustees of the American Museum of Natural History, for their kindness and courtesy in allowing the Annual Reception to be held in the Museum, under such favorable auspices, and at such a moderate expense to the Academy.

The Council feels that the success and increased interest evident in the meetings since the removal of the meeting place to its present building (12 West 31st Street) is a very pleasing feature in the Academy's work. Almost without exception the meetings of the various sections have been individually and as a whole largely increased in attendance during the last year and a-half.

"The work of the Recording Secretary's office has been systematized and in many ways improved during the last year, so that the necessary and frequent details are managed more efficiently and with less expenditure of energy and time."

The Treasurer reported cash on hand \$2239.11, with total assets of \$15,059.11.

The Librarian reported that the library consisted in round numbers of about 9000 volumes, of which hardly 5 per cent. are in separate title. During the year the library has been well housed in Schermerhorn Hall, Columbia University, the card catalogue and shelf list have been rearranged and the library in every way has been made more workable and serviceable.

The Editor reported that Vol. XII. of the *Annals*, now in press, of which one part has already appeared, contains 14 papers, and about 600 pages. He also reported the appearance of Part I., Vol. II. of the *Memoirs*, devoted to 'The So-Called Devonian Lamprey, *Palæospondylus gunni*,' by Dr. Bashford Dean. The edition of the *Annals* has been increased from 1000 to 1250, and the exchange list has been extensively revised.

The following Honorary and Corresponding Members were then elected, and nine resident members were, 'because of their scientific attainments and services,' made Fellows:

Honorary Members.—Julius Hann, Ph.D., University of Graz; Edward Charles Pickering, LL.D., Harvard University; Jules-Henri Poincaré, F.R.S., Faculty of Sciences, Paris; Henry Augustus Rowland, LL.D., Johns Hopkins University; Edward Burnett Tylor, D.C.L., LL.D., F.R.S., University of Oxford.

Corresponding Members.—Albert De Lapparent, École Libre de Hautes Études, Paris; William Henry Holmes, United States National Museum, Washington, D. C.; Kakichi Mitsukuri, Ph.D., Imperial University of Tokyo, Japan; George Howard Parker, Ph.D., Harvard University, Charles Richard Van Hise, Ph.D., University of Wisconsin; Sho Watasé, Ph.D., Imperial University of Tokyo, Japan.

Fellows.—Dr. W. S. Day, Secretary Section of Astronomy, Physics and Chemistry; James Douglas, President American Institute of Mining Engineers; Jonathan Dwight, Jr., Ornithologist; Dr. Marshall A. Howe, Curator Columbia University Herbarium; Professor Charles H. Judd, Professor of Psychology, New York University; Dr. E. G. Love, Entomologist; Alfred W. Trotter, Mining Expert and Civil Engineer; Dr. Henry S. Washington, Petrographer; Dr. Theodore G. White, Paleontologist.

The list of officers given below was then elected by ballot:

President: Robert S. Woodward.

First Vice-President: Charles A. Doremus.

Second Vice-President: Franz Boas.

Corresponding Secretary: William Stratford.

Recording Secretary: Richard E. Dodge.

Treasurer: Charles F. Cox.

Librarian: Livingston Farrand.

Councillors: Daniel W. Hering, Frederic S. Lee, Harold Jacoby, M. I. Pupin, Edw. L. Thorndike, L. M. Underwood.

Curators: Harrison G. Dyar, Alexis A. Julien, George F. Kunz, Louis H. Laudy, E. G. Love.

Finance Committee: Henry Dudley, John H. Hinton, Cornelius Van Brunt.

After a brief address by the President-Elect, the retiring President delivered his presidential address, entitled 'The Geological and Faunal Relations of Europe during the Tertiary period, and the Theory of the Successive Invasions of the Ethiopian Fauna,' which will be printed in this JOURNAL.

RICHARD E. DODGE,
Recording Secretary.

AMERICAN MATHEMATICAL SOCIETY.

THE first number has recently appeared of the *Transactions of the American Mathematical Society*, published quarterly by the Society with the coöperation of Harvard University, Yale University, Princeton University, Columbia University, Haverford College, Northwestern University, Cornell University, The University of California, Bryn Mawr College, The University of Chicago; edited by Eliakim Hastings

Moore, Ernest William Brown, Thomas Scott Fiske; New York, The Macmillan Company. The *Transactions*, which is devoted to the publication of important researches presented at the meetings of the Society, is quarto in size, and the annual volume will contain not less than five hundred pages. The contents of the first number are noted elsewhere.

The Annual Register of the Society has recently been issued, and contains a directory list of publications, list of officers and members, Consitution and By-Laws, and annual reports. Copies may be obtained from the Secretary.

A regular meeting of the Society was held at Columbia University on Saturday, February 24, 1900. As usual, the programme occupied a morning and an afternoon session. President R. S. Woodward occupied the chair. A part of the afternoon was devoted to a joint meeting with American Physical Society, at which a paper on Latitude Variation was presented by Professor J. K. Rees.

A revision of the By-Laws, affecting mainly their arrangement, was adopted. Notice was also given of a proposed amendment of the Constitution enlarging the Council by making the ex-presidents permanent members and increasing the number of elected members by three. The following persons were elected to membership in the Society: Professor Anne L. Bosworth, Rhode Island College, Kingston, R. I.; Mr. H. L. Coar, University of Illinois, Urbana, Ill.; Dr. F. R. Moulton, University of Chicago, Chicago, Ill.; Mr. F. G. Radelfinger, Hydrographic Office, Washington, D. C. Two applications for membership were received.

The following papers were presented at this meeting:

(1) DR. ALEXANDER MACFARLANE: 'On the nabla of quaternions.'
(2) DR. M. B. PORTER: 'On the number of roots of $F(\alpha, \beta, \gamma, x)$ between zero and 1.'
(3) MR. H. W. KUHN: 'List of the imprimitive groups of degree fifteen.'
(4) DR. G. A. MILLER: 'On the groups of isomorphisms.'
(5) DR. J. I. HUCHINSON: 'The Hessian of the cubic surface, II.'
(6) PROFESSOR MAXIME BÔCHER: 'Some theorems concerning linear differential equations of the second order.'
(7) PROFESSOR J. K. REES: 'Results of seven years' observations for variation of latitude and the constant of aberration, made at the Columbia University Observatory.'
(8) DR. G. W. HILL: 'On the extension of Delaunay's method in the lunar theory to the general problem of planetary motion.'
(9) PROFESSOR E. B. VAN VLECK: 'On linear criteria for determining the circle of convergence of a power series.'
(10) PROFESSOR F. MORLEY: 'The metrical geometry of the plane n-line.'
(11) PROFESSOR L. E. DICKSON: 'Two triply infinite systems of non-isomorphic simple groups of equal order.'
(12) PROFESSOR L. E. DICKSON: 'Isomorphism between certain systems of simple linear groups.'
(13) DR. L. W. REID: 'A table of class numbers for cubic number bodies with the method of their calculation.'

After the meeting many of the members dined and passed a pleasant evening together. The next meeting of the Society will be held on Saturday, April 28th. The Chicago Section meets at Northwestern University, Evanston, Ill., on Saturday, April 14th. The summer meeting of the Society will be held in New York, in June, in affiliation with the meeting of the American Association for the Advancement of Science.

F. N. COLE,
Secretary.

COLUMBIA UNIVERSITY.

THE TEXAS ACADEMY OF SCIENCE.

THE regular monthly meeting of the Texas Academy of Science was held in the Chemical lecture room of the University of Texas on Friday evening, January 12th, President Simonds in the chair.

The first paper on the program, entitled, 'The Red Sandstone of the Diablo Mountain, Texas,' was by Mr. E. T. Dumble, of Houston, formerly State Geologist. The sandstone here discussed is found north of Allamore station on the Texas and Pacific Railway, and is the rock enclosing the copper vein, a part of which has been known for some years as the Hazel mine. Professor Streeruwitz in one of his reports on the region states that this formation is possibly Devonian, basing his statement, as Mr. Dumble understands it, entirely on the petrographic character of the rock, as it contains no fossils, and on its relation to the Carboniferous deposits in the hills north of the mine. Mr. Dumble has studied this sandstone, if it really be such, with considerable care, and finds it to occupy a position much lower in the geological scale than had been previously thought—that it is, in fact, below the Texan Group of Comstock—that is, at the very base of the sedimentary series. He does not believe that it is a part of an immense mass or boss of igneous material.

Mr. A. C. McLaughlin, for several years past connected with the Geological Survey of Maryland, gave an account of the work as conducted by that organization in the western part of the State.

Professor T. U. Taylor, of the Department of Engineering, read and commented upon a communication received from Professor W. H. Echols, of the University of Virginia, on the 'Measure of Earthwork,' in which the prismatic formulæ were employed.

Dr. S. E. Mezes followed with a paper on 'Monogamous Marriage,' in which he gave an account of this institution and of the rules and customs by which it has been maintained. That this institution is adapted to the highest civilization was shown in the fact that by it, and it alone, could be made a home, and that the home-training of children produced the highest and best results socially. The paper was both thoughtful and candid and received the hearty approval of all who heard it.

F. W. S.

UNIVERSITY OF TEXAS.

DISCUSSION AND CORRESPONDENCE.

MARGINAL TABS FOR LOGARITHM TABLES.

To THE EDITOR OF SCIENCE: Will you permit me, through the columns of SCIENCE, to bring to the attention of users of my 'Computation Rules and Logarithms,' a set of 'Marginal Tabs' for use in that book. The tabs are arranged for the five-place tables of logarithms of numbers and of the trigonometrical functions. They not only materially lessen the time required to find any logarithm or antilog in the use of the tables to five places, but they render the table even more speedy than the ordinary four-place table for obtaining the logarithms or antilogs to four places, while also much lessening fatigue and liability to mistake, no interpolation being required. The printed tabs, with directions for their application and use, form a leaflet which will be mailed by the author on receipt of twenty-five cents. Copies of the *errata* of the first (very thick paper) impression of the Tables, but which have been corrected in later impressions, will be mailed to holders of that edition on receipt of a stamped and addressed envelope.

S. W. HOLMAN.

18 ELM STREET, BROOKLINE, MASS.,
February 24, 1900.

NOTES ON PHYSICS.

IN the London *Electrician* is a report of some recent experiments of Professor S. Lussana on the variation of resistance under high pressures, up to 1000 atmospheres. He found the resistance to decrease with increase of pressure, and obtained the following coefficients per atmosphere.

Lead	194×10^{-7}		
Iron	38	Argentana	9.7×10^{-7}
Silver	32	Nickelina	7.4
Copper	31	Constantea	7.9
Platinum	24	Manganin	5.6
Nickel	19	Brass	4.3

The curves of decrease of resistance were slightly concave toward the axis of pressure, showing a tendency toward a minimum.

The resistance did not return to its normal immediately on removal of the pressure. In the case of platinum which had been under a pressure of 500 atmospheres for one hour, the resistance, on removal of the pressure, increased rapidly for ten minutes, and then quite slowly, taking about one hour to return to approximately its normal. Held under the same pressure for 24 hours, the curve showing its return with time to normal resistance is very interesting, rising in about 50 minutes to normal, going above, returning again to normal in about 7½ hours, falling below, and again becoming approximately normal in about 14 hours, thus showing a series of waves of decreasing magnitude and increasing length.

In the same journal of January 26th is an abstract of a Royal Society paper by C. E. S. Phillips, on 'Diselectrification produced by Magnetism.' Foil was cemented on the inner and outer surfaces of a glass tube, and powerful magnet poles were inserted through air-tight flanges. When the tube was exhausted below .2″ of mercury, and the inner coating was connected to the positive side of an electrical machine, an electroscope attached to the inner coating showed a rapid discharge on opening or closing the circuit of the magnet. With higher pressures or when the inner coating was negative there was no effect. When the electroscope was attached to the iron of the magnet poles, it indicated that the charge was transferred to these.

F. C. C.

ZOOLOGICAL NOTES.

BIRD MIGRATION.

IN a recent issue of the *Proceedings of the California Academy of Sciences*, Leverett M. Loomis gives a fourth part of his 'California Water Birds,' including his deductions from a careful study of their migrations. He concludes that the Shearwaters off Monterey find their position and shape their course by landmarks, and that birds possess no mysterious superhuman faculty for determining direction, or else these same Shearwaters would not have been bewildered in the fog. He also considers that the young are guided from the place of their birth to their winter abode through the experience of the older birds, and that the mere presence of young alone in a locality does not prove that they are migrating independently of the adults, but that older birds have either continued their flight or are migrating farther off. Mr. Loomis sums up by saying that bird migration is a habit evolved by education and inheritance which owe their origin and perpetuation to winter, with its failure of food.

THE STEREORNITHES AGAIN.

IN the December number of *Communicaciones del Museo Nacional de Buenos Aires*, Senor Mercerat discusses the zoological position of the gigantic birds from the Santa Cruz beds of Patagonia, and considers them as an independent 'gens' of the suborder Ciconiiformes of Fürbringer. While this is all right, Senor Mercerat unfortunately adds that the Stereornithes are a degenerate group of birds, but that they have not progressed so far on their downward course as the so-called Ratitae, and that they present numerous characters similar to those of the Carinatae, combined with others peculiar to the Ratitae. What these ratite characters are, aside from the feeble development of the wings, no one has yet satisfactorily explained, and Mr. C. W. Andrews, in his recent memoir on *Phororhacos*, shows very clearly that the Stereornithes have no kinship with the Ostriches. Size and flightlessness are not morphological characters and have no bearing whatever on the systematic position of the bird. It was a favorite remark of the late Professor Cope that an animal a mile long and an inch wide might belong to the same genus as one a mile wide and an inch long, and this might be paraphrased by saying that a bird with wings twenty feet across might be the nearest relative of a bird with no wings at all.

F. A. L.

THE ASSAY COMMISSION.

THE Assay Commission, which is appointed annually by the President to test the weight and fineness of the coinage of the mints in operation during the preceding year, met at the Philadelphia mint on February 14th. The men whom President McKinley designated to serve for the year 1900 were: Senator John P. Jones, of Nevada; Representative E. J. Hill, of Connecticut; Dr. H. S. Pritchett, Superintendent of the Coast and Geodetic Survey; Professor S. A. Lattimore, of the University of Rochester; Professor H. H. Nicholson, of the University of Nebraska; Dr. J. A. Mathews, of Columbia University; Dr. Cabell Whitehead, Assayer of the Bureau of the Mint; Dr. Marcus Benjamin, of the Smithsonian Institution; Hon. John H. Perry, of Connecticut; Calvin Cobb of Boise, Idaho; Thomas B. Miller of Helena, Montana; Edward Harden, of New York City; E. H. Rich, of Fort Dodge, Iowa, and Francis Beidler, of Chicago. The Commission also includes three ex-officio members, viz., the judge of the District Court of the

Eastern District of Pennsylvania, Judge McPherson; the Comptroller of the Currency, Hon. Charles G. Dawes, and the Assayer of the New York Assay Office, Dr. Herbert G. Torrey.

The work of the Commission consists in counting, assaying and weighing samples representing the coinage of the mints at Philadelphia, New Orleans and San Francisco. For this trial one one-thousandth of all gold coins and one two-thousandth of all silver coins made during the year are sent to the Philadelphia mint under seal and kept for the meeting of the Commission. The coinage during the past year was larger than ever before and hence the labor of the Commission was increased. The trial pieces numbered over forty-one thousand. The work of the Commission was divided among three committees; the chairman of which, as announced by Mr. George C. Roberts, Director of the Mint were: Counting, Hon. E. J. Hill; Assaying, Dr. H. S. Pritchett; Weighing, Dr. J. A. Mathews. The investigations of these committees serve as a check upon the accuracy of the work at the several mints, as well as upon the Bureau of the Mint in Washington.

SCIENTIFIC NOTES AND NEWS.

Since making appropriations in March, 1899, of $500 to Professor Charles L. Doolittle, and of $300 to Mr. Henry M. Parkhurst, from the Benjamin Apthorp Gould Fund, a considerable additional amount of income has accrued, for the distribution of which the Directors are prepared immediately to arrange. Applications for appropriations may be made by letter to Mr. Lewis Boss, Albany, Dr. Seth C. Chandler, Cambridge, or to Professor Asaph Hall, Cambridge.

An item in the Urgency Deficiency Bill, which has now passed both Houses of Congress, makes an appropriation of $7500, for continuing the biological and economic investigations on the lobster and clam. The investigations deal with the practical aspects of the subject, and it is purposed to carry on the work in all States having clam and lobster fisheries, from Maine to Delaware inclusive.

A committee, consisting of Mr. James E. Scripps, Mr. George W. Bates, of Detroit, and Professor Francis W. Kelsey, of the University of Michigan, was appointed at the annual meeting of the Detroit branch of the Archæological Institute of America, and was instructed to name a general committee to prepare a memorial to be submitted to the next State Legislature on the subject of an archæological survey of Michigan. The present knowledge of Michigan archæology is meagre, and is given in 'The Data of Michigan Archæology,' by Harlan I. Smith, published in the *American Antiquarian* for May, 1896.

The University of Edinburgh will confer the degree of LL.D., on Eleanor A. Ormerod, the entomologist. The University of Edinburgh has not hitherto conferred an honorary degree on a woman.

Wabash College, situated at Crawfordsville, Indiana, has conferred an honorary degree of Ph.D. on Professor Asa H. Morton, professor of romance languages, at Williams College. If Professor Morton has not been consulted in regard to this doubtful honor, he may see fit to decline it.

Dr. Charles W. Dabney, president of the University of Tennessee, has received notice from the French Government of his appointment as a member of the Committee on International Awards at the Paris Exposition.

Professor R. W. Wood, of the University of Wisconsin, who is now in England, will return to Madison at the end of March after visiting Berlin and Paris.

Mr. William C. Whitney has presented two fine bisons to the New York Zoological Park. One of them is from the herd of the late Austin Corbin at Blue Mountain Park, N. H. The other is from Mr. Whitney's herd at Lennox, Mass.

Professor E. J. McWeeny, professor of pathology and bacteriology at the Catholic University of Dublin, has been appointed to the newly created post of bacteriologist to the Irish Local Government Board.

The trustees of the Philadelphia Academy of Surgery announce that the Samuel D. Gross prize was not awarded on January 1st, as no suitable essay was presented. It will be awarded on October 1, 1901. The prize, the value of which is $1,000, is awarded to an American citizen for an essay not exceeding 150 octavo pages, containing original investigations on surgical pathology or surgical practice.

THE Senate Sub-Committee, responsible for the bill interfering with vivisection in the District of Columbia, gave a hearing on February 21st. Among those who opposed the bill were Professor H. P. Bowditch, Surgeon General Sternberg, Professor W. W. Keen, Professor W. H. Welch, Professor William Osler, Professor Howard A. Kelly, Professor H. H. Hare, Dr. Mary P. Jacobi, and Bishop Lawrence.

WE regret to record the death of M. Émile Blanchard, member of the section of anatomy and zoology of the Paris Academy of Sciences.

WE must also announce the death at the age of 76 years of Dr. Hermann Schaeffer, honorary professor of mathematics at Jena.

IT is perhaps not generally known that the late Professor D. E. Hughes, the physicist and inventor, whose death we were recently compelled to record spent about twenty years in the United States. He was educated at Bardstown, Ky., where he afterwards taught 'natural philosophy.'

THE first part of Römer und Schaudinn's *Fauna Arctica* has appeared. It is a beautiful quarto, and contains papers by Schulze, Thiele, von Linstow and Ludwig, on the Hexactinellidæ Proneomenia, the Nematodes and Holothurians, respectively.

DURING the present month lectures on metallurgy are being given at the American Museum of Natural History under the auspices of Columbia University. The lectures, which are on Saturday evenings, are as follows:

March 3. 'The Constitution of Steel as revealed by the Microscope,' by Professor Henry M. Howe, of Columbia University.

March 10. 'The Constitution of Metallic Alloys in the Light of Modern Research,' by Mr. Albert Sauveur, Lecturer on Metallurgy, Harvard University.

March 17. 'Toledo Blades: Rationale of the Procedure in Manufacturing them and other Steel Objects explained by the Microscope,' by Henry Souther, Consulting Engineer, of Hartford, Conn.

March 24. 'Lead Smelting in the United States,' by Professor H. O. Hofman, of the Massachusetts Institute of Technology, Boston, Mass.

March 31. 'Aluminium,' by Professor J. W. Richards, of the Lehigh University, South Bethlehem, Pa.

THE thirteenth Lecture Course on science and travel at the Field Columbian Museum will be given during March and April on Saturday afternoons at 3 o'clock. The subjects and dates of lectures are as follows:

March 3. 'The Age of Steel,' by Mr. H. W. Nichols, Assistant Curator, Department of Geology, Field Columbian Museum.

March 10. 'Conditions of Life in Inland Lakes,' by Dr. E. A. Birge, Professor of Zoology, University of Wisconsin.

March 17. 'Gigantic Fossil Reptiles from the Jurassic of Wyoming,' by Mr. E. S. Riggs, Assistant Curator of Paleontology, Field Columbian Museum.

March 24. 'Primitive American Art with Illustrations Drawn chiefly from Studies in Aboriginal Games,' by Mr. Stewart Culin, Director of the Museum of Science and Art, University of Pennsylvania.

March 31. 'Archæological Discoveries on the North Pacific Coast of America, by Mr. Harlan I. Smith, American Museum of Natural History, New York.

April 7. 'Soyaluna, a Hopi Winter Solstice Ceremony,' Stanley McCormick Expedition, by Rev. H. R. Voth, Missionary to the Hopi Indians.

April 14. 'The 'Struggle for Existence' as a Factor in Animal Development,' by Dr. D. J. Rettger, Indiana State Normal School, Terre Haute, Indiana.

April 21. 'The Yellowstone National Park,' by Professor J. P. Iddings, University of Chicago.

April 28. 'Indian Tribes of the Great Plains,' by Mr. James Mooney, Bureau of Ethnology, Washington, D. C.

A TELEGRAM has been received at the Harvard College Observatory from Professor J. E. Keeler at Lick Observatory stating that the following elements and ephemeris of Comet '*a*' were computed by Professor Perrine.

Time of passing perihelion	$= T =$ 1900 April 29.08
Perihelion minus node	$= \omega =$ 24° 37′
Longitude of node	$= \Omega =$ 40° 25′
Inclination	$= i =$ 146° 25′
Perihelion distance	$= q =$ 1.3289

Ephemeris.

1900 Feb. 26	R.A. $2^h\ 09^m\ 52^s$	Dec. $+1°\ 43′$	Lat. 0.85
Apr. 2	" 2 05 36	" 2 56	
Mar. 6	" 2 01 52	" 4 07	
Mar. 10	" 1 58 32	" +5 15	Lat. 0.82

Computed from observations on February 3d and 8th.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. A. W. Grabau has been appointed instructor in geology in the Rensselaer Polytechnic Institute, Troy, N. Y.

Oberlin College receives $75,000 by the will of the late Mrs. Caroline E. Haskell of Michigan City, Indiana, and $40,000 by the will of the late William Osborne of Pittsburg.

By provision of the will of the late Dr. John Stanford Sayre, U. S. N., retired, Princeton University will receive $40,000, part of which is for the endowment of fellowships in applied chemistry and in applied electricity.

Under the will of the late Mr. Joseph Kaye, the Medical Department of the University College of Sheffield has received £1000 for the purpose of founding a scholarship for second-year students.

We learn from *Nature* that by the will of the Mr. W. Hiddingh, who died on December 10, 1899, the University of the Cape of Good Hope is bequeathed the sum of 5000*l.* for the foundation of a scholarship to enable young persons to pursue and complete a course of professional study, the scholarship to be tenable for four years. To the University is also bequeathed the sum of 25,000*l.* for the purpose of building a university hall and suitable university offices, and a large piece of ground for the site of the building. The South African College will receive the sum of 10,000*l.* for the erection of a students' building.

The University of Nebraska celebrated its thirty-first anniversary on February 15th, known as 'Charter Day,' by an oration by Dr. Allen R. Benton, Chancellor from 1871 to 1876, and since then of the faculty of Butler University, Irvington, Ind. After the oration, degrees were conferred upon six students who had completed the work for the degree of B.A., and upon one who had completed the work for the degree of B.Sc. The Regents, at their Charter Day meeting, discussed again the all-year-plan, *i. e.*, the plan of having four quarters of instruction, as in the University of Chicago. The subject was again referred to the Regents' Committee on Courses of Study. Dr. T. L. Bolton, of Clark University, was elected Instructor in Philosophy, to fill the place made vacant by the recent death of Dr. Leon M. Solomons. Although the chancellorship was discussed, no election was made. It is the expectation of the Regents to make an election at their April meeting. The new Experiment Station Hall was accepted from the contractors, and it will be occupied at once. A contract was let for the completion of Grant Memorial Hall, by the building of a large transept which will double the capacity of the hall. The sugar-beet industry, in Nebraska, having passed the experimental stage, the Regents ordered the discontinuance of the sugar-beet experiments on the Experiment Station.

Another bill has been introduced into the Senate, establishing a University of the United States. The bill provides that the government of the university shall be vested in a board of regents to be composed of the President of the United States, who shall be president of the board; the Chief Justice of the United States, who shall be vice-president of the board; the commissioner of education, the president of the university, the secretary of the Smithsonian Institution, the president of the National Academy of Sciences, the president of the American Association for the Advancement of Science, the president of the National Educational Association, the president of the American Association of Agricultural Colleges and Experimental Stations, the president of the American Historical Society, the president of the Washington Academy of Sciences, the presidents of the ten institutions of learning exclusive of State universities having the largest number of graduate students doing systematic original work; the presidents of the ten State universities having the largest number of graduate students engaged in like manner; the presidents of the ten other institutions, in as many States, not otherwise represented, having the largest number of students in the senior class of the academic departments, and six other citizens who, with their successors, shall be appointed by the President of the United States, by and with the advice and consent of the Senate. It is provided that 'University Square,' recently occupied by the old naval observatory, in this city, be the site for the national university.

MEDAL IN HONOR OF DANIEL GARRISON BRINTON.

Struck by the Numismatic and Antiquarian Society of Pennsylvania.

SCIENCE

Friday, March 16, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

DANIEL GARRISON BRINTON.

The Memorial meeting in honor of the late Dr. Daniel Garrison Brinton was held at the hall of the Historical Society of Pennsylvania on the evening of the 16th of January, under the auspices of the American Philosophical Society, by twenty-six learned societies. The societies represented at the meeting were:

Academy of Natural Sciences of Philadelphia.
American Antiquarian Society.
American Association for the Advancement of Science.
American Folk Lore Society.
American Museum of Natural History.
American Oriental Society.
American Philosophical Society.
Anthropological Society of Washington, D. C.
Bureau of American Ethnology.
Chester County Historical Society.
Field Columbian Museum.
Geographical Society of Philadelphia.
Historical Society of Pennsylvania.
Jefferson Medical College.
Loyal Legion.
Modern Language Association of America.
New Jersey Historical Society.
Numismatic and Antiquarian Society of Philadelphia.
Oriental Club of Philadelphia.
Peabody Academy of Science.
Peabody Museum of American Archæology and Ethnology.
Smithsonian Institution.
United States National Museum.
University of Pennsylvania.
Wyoming Historical and Geological Society.

The program of the meeting was as follows:

1. Introductory by the presiding officer, representing the American Philosophical Society, by Provost Charles C. Harrison.

2. Presentation of an oil portrait of Dr. Brinton, the gift of friends to the American Philosophical Society, by Hon. Samuel W. Pennypacker.

3. Acceptance on behalf of the American Philosophical Society, by Dr. J. W. Holland.

4. Memorial Address, by Professor Albert H. Smyth.

5. Presentation of a collected set of Dr. Brinton's works, the gifts of his family to the American Philosophical Society, by Rev. Jesse Y. Burk.

6. Acceptance in behalf of the American Philosophical Society, by Mr. Joseph G. Rosengarten.

7. Address by Major J. W. Powell, of Washington, D. C.

8. Presentation of a medal bearing Dr. Brinton's portrait in relief, the gift of the Numismatic and Antiquarian Society to the American Philosophical Society, by Mr. Stewart Culin.

9. Acceptance on behalf of the American Philosophical Society, by Dr. J. Cheston Morris.

10. Address on the Ethnological Work of Dr. Brinton, by Dr. W J McGee, of Washington, D. C.

The meeting was called to order by provost Charles C. Harrison of the University of Pennsylvania and letters of regret were read from Major J. W. Powell, Miss Alice C. Fletcher, Mr. Frank Hamilton Cushing, The Marquis de Nadaillac and others.

Provost Harrison in his opening address, after eulogizing Dr. Brinton's attainments and services to science, referred to his gift to the University of Pennsylvania, before his death, of his priceless library of books on American languages and suggested that a Professorship of American Archæology be founded at the University to bear the title of the 'Brinton' chair.

The portrait of Dr. Brinton, presented by a number of his friends to the American Philosophical Society, was painted by Thomas Eakins, an artist who had known Dr. Brinton intimately.

The presentation of the portrait was made by the Hon. Samuel W. Pennypacker, Vice-President of the Historical Society of Pennsylvania, and accepted by Dr. J. W. Holland, Dean of the Jefferson Medical College, where Dr. Brinton had received his medical education. Professor Albert H. Smyth then delivered the Memorial address which was followed by the presentation to the American Philosophical Society by the Rev. Jesse Y. Burk of a complete set of Dr. Brinton's published works, a gift to the Society from Mrs. Brinton.

Major Powell was unable to be present on account of illness and his place on the program was assigned to Professor F. W. Putnam who urged the foundation of a memorial chair of Anthropology in the University of Pennsylvania in honor of Dr. Brinton, "covering the whole subject in the broad way which Dr. Brinton himself covered it in his lectures to students."

Mr. Culin then presented in behalf of the Numismatic and Antiquarian Society of Pennsylvania a bronze medal of Dr. Brinton cast by Mr. John Flanagan an American artist in Paris, and struck by the Society in commemoration of the 40th anniversary of its existence and the 15th of Dr. Brinton's presidency.

After the acceptance of the medal by Dr. Cheston Morris, on behalf of the American Philosophical Society, Dr. W J McGee delivered an address on the ethnological work of Dr. Brinton.

The meeting was largely attended, the societies participating sending delegates who were present.

A full report of the proceedings will be published in the Memorial Volume of the Philosophical Society which is about to go to press, and an edition of the part relating to the Brinton meeting will be printed and bound separately for distribution to libraries and institutions. This book will contain a bibliography.

THE FACILITIES AFFORDED BY THE OFFICE OF STANDARD WEIGHTS AND MEASURES FOR THE VERIFICATION OF ELECTRICAL STANDARDS AND ELECTRICAL MEASURING APPARATUS.

THE need of adequate facilities for the official verification of standards and measuring apparatus of all kinds, has long been recognized by American physicists. The Office of Weights and Measures, with its small force, modest equipment and insufficient appropriations, has endeavored to meet any demands imposed upon it within the limits thus set.

The object of this article is to describe what has thus far been accomplished along electrical lines, and in this connection a brief history of the units of reference may not be considered out of place.

The origin of standards of quantity and value dates back as far as the earliest historical records. The transition from the crude measures of antiquity to the systems meeting present requirements has, however, been exceedingly slow, although the growth of commercial intercourse gradually led to the introduction of more precise standards.

The requirements of accuracy were, nevertheless, quite modest until physics began to emerge from its qualitative stage to assume the dignity of an exact science.

The number and complexity of physical quantities at first led to the adoption of more or less arbitrary standards of reference, often based on the physical properties of some definite substance, *e. g.*, the calorie, and as long as the relations between physical quantities remained obscure, such relative standards sufficed. With the development of the science came the recognition of the desirability of a consistent system of units, which was strongly brought to the front, when it became necessary to measure magnetic quantities.

The happy solution of this problem suggested by Gauss and extended to the measurement of electrical and electro-magnetic quantities by Weber, constituted a great advance in the science of Metrology, the units being defined in terms of the mechanical actions to which they give rise. Since all mechanical units can be expressed in terms of three independent fundamental units, such as those of length, mass and time, the magnetic and electrical units of Gauss and Weber are thus expressible in terms of the same fundamental units and are therefore entirely independent of the physical properties of arbitrarily chosen substances. Hence they are called absolute units, their magnitudes depending solely on the choice of the fundamental units.

The units of length and mass selected were usually multiples or sub-multiples of the corresponding metric units, the metric system being the only one meeting the highest scientific and practical requirements and being already in extensive use. While at first uniformity in the selection of the magnitudes of the fundamental units was lacking, the centimeter, gram and second have now been universally adopted, the derived units being known as C. G. S. units.

Practical measurements of electrical resistance were, however, first referred to a variety of arbitrary standards, *e. g.*, the resistance of a given length of copper or iron wire of given diameter, and so long as electrical measurements were confined to the laboratory, the length referred to was usually a few feet, but with the practical applications of electricity to telegraphy and submarine signaling, this length became inconveniently small and was therefore replaced by fathoms, miles, etc. Fortunately none of these units ever gained general acceptance. In 1848 Jacobi pointed out that it would be far preferable to adopt, as a universal standard, the resistance of a certain piece of wire, copies *having the same resistance* being easily constructed.

Jacobi carried this suggestion into practice by sending a piece of copper wire, since known as 'Jacobi's Étalon' to various physicists for that purpose.

In 1860 Werner von Siemens proposed as a standard of resistance, the resistance, at 0°C., of a column of mercury, 1 sq. mm. in cross section and 100 cm. in length.

In 1861 a committee, composed of the most eminent English physicists was appointed by the British Association to consider the question of Standards of Electrical Resistance. Correspondence was opened with the leading foreign physicists and various special investigations of the problems, with which the committee was confronted, were undertaken by its members.

The first question settled was that the unit of resistance should be defined as a multiple by an integral power of 10 of the unit of Weber's absolute system, and that the unit chosen should be of a convenient magnitude. Accordingly, a unit equivalent to 10^9 C. G. S. units was adopted.

This definition fixed the unit, but the evaluation of a resistance in absolute measure requires the construction of especially designed apparatus, having usually a limited range of usefulness ; the determination of instrumental constants, most frequently involving tedious mathematical approximations, and in addition, the observations have to be made with the greatest precision. On the other hand, relative measurements require simpler apparatus and less skill in manipulation, besides being, in most cases, far more accurate than absolute measurements. The construction of material standards adjusted to the specified resistance, determined once for all by a series of absolute measurements, was therefore decided upon.

Investigations were made to determine whether the absolute unit of resistance could be accurately defined in terms of the resistance of a definite portion of a definite substance. Pure metals in the solid and liquid state and alloys were studied with this end in view. On account of the excessive influence on the resistance produced by small quantities of impurities in metals and by small variations in the composition of alloys and on account of the additional difficulty of procuring chemically pure materials, the choice was greatly limited. Moreover solids had to be rejected on account of the marked effect of physical changes produced by drawing, bending, annealing, etc.

Mercury, already recommended by Siemens, was therefore the only material to be further considered. Even this material was rejected, owing to large differences found to exist between coils, supposedly adjusted to agree with different German mercury standards, and the mercury standards constructed by members of the committee.

Having abandoned the above propositions, the alternative remained of constructing material standards adjusted with reference to the absolute unit.

A number of new alloys, in addition to many already in use, were made and investigated. An alloy of 2 parts by weight of silver to 1 part by weight of platinum was finally selected as best meeting all requirements. A special form of resistance standard was also adopted.

In 1863 and 1864 the values of certain coils were determined in absolute units by one of the methods proposed by Weber and from these measurements the B. A. unit was derived. A number of copies were issued gratis by the Association and in addition arrangements were made to furnish others at a moderate price. The B. A. unit soon gained universal acceptance in the English speaking countries, while the Siemens unit still retained its supremacy on the continent.

In 1878 it was shown by Professor Rowland that the B. A. unit differed from its assumed value by more than one per cent. and soon after, this difference was substantiated by a number of other investigators.

In 1881 a call was issued, in connection with the first Paris electrical exhibition, for an international electrical congress for the purpose of adopting definitions of the electrical units to serve as a basis for legislative enactments. Numerous mercury standards had in the meantime been constructed and had been found to agree most satisfactorily with one another; moreover, the results of a considerable proportion of the absolute determinations made had been referred, directly or indirectly, to the Siemens unit. In view of this, the Paris Congress passed a resolution recommending that all absolute determinations in the future be expressed as the resistance of a column of mercury of stated length, 1 sq. mm. in cross section at the temperature of melting ice, and that the C. G. S. electro-magnetic system of units be adopted. The desirability of making new determinations of the ohm was urged.

Three years later the Congress reassembled at Paris and adopted 106 cm. as the length of the specified column of mercury, individual results still differing by as much as ± .5 per cent. The unit of resistance thus defined was called the legal ohm, but while it was never legalized anywhere, it nevertheless came into extensive use, especially in England and in America.

Absolute methods were gradually improved, sources of error were pointed out, and eliminated as far as possible and accordingly the results of absolute determinations, made by the most radically different methods, became more concordant.

The International Electrical Congress (which met in Chicago in 1893), through its Chamber of Delegates, officially representing all the leading governments, therefore adopted, as the unit of resistance, the mean of all the best determinations, the resistance at 0° C. of a column of mercury 106.3 cm. in length and of uniform cross section having a mass of 14.4521 gm. (equivalent to a cross section of 1 sq. mm., the density of mercury being assumed to be 13.5956). The unit of resistance and the other electrical units defined by the International Congress were legalized in the United States by Act of Congress in 1894, and have also been legalized in the other countries represented.

It was generally supposed that the various governments would sooner or later take up the construction of mercury standards as called for in the definition since each had already been provided by the International Bureau of Weights and Measures with the fundamental standards of mass and length.

The Imperial Physico-Technical Reichsanstalt in Berlin has already begun this task with its characteristic thoroughness. Two one ohm mercurial standards were constructed and later, a third together with a ½ and a two ohm tube. Widely different cross sections were purposely selected to avoid possible sources of error. The calibration and intercomparison of these standards leaves almost nothing to be desired, measurements made by two different methods, both yielding the same results within the limits of experimental error.

Twelve mercury copies were also constructed; these, together with 7 working standards of manganin wire, periodically referred to the primary standards, complete the list.

In England, on the other hand, the B. A. coils have still been retained as primary standards. The legal ohm was defined in that country by the relation, 1 Siemens unit = .9540 B. A. units, and later the International Ohm was defined by the relation, 1 Siemens unit = .95351 B. A. units. According to a comparison made several years ago, 1 Siemens unit, as derived from the Reichsanstalt Standards, is equal to .95341

B. A. units, indicating a change in the coils themselves, or in their assumed relation to the Siemens unit or in both.

Matters have been still further complicated in England by the legalization of the resistance of a coil marked 'Board of Trade Standard verified 1894,' and adjusted with reference to the Cambridge Standards, as the unit of resistance.

A still more radical suggestion was made in that country several years ago, by Professor A. Viriamu Jones and Professor W. E. Ayrton, that each government adopt a Lorenz apparatus from which to derive by absolute measurements the unit of resistance. The practical substitution of an absolute method with its disadvantages as pointed out above, for a purely relative one seems to be taking a step or indeed several steps backward, but may be taken as indicating the lack of confidence in the permanency of the B. A. coils.

After the legalization of the International Electrical Units it became the imperative duty of our government to provide facilities for the official verification of electrical standards and electrical measuring apparatus, especially in view of the continually increasing importance of the applications of electrical energy to the industral arts. This function obviously devolved upon the Office of Standard Weights and Measures. already equipped for the verification of standards of length, mass, capacity, etc.

Owing, however, to the limited force and to the still more limited appropriations available for the purchase of apparatus, practically nothing could be done until July 1, 1897, when the appointment of a verifier was authorized, but unfortunately progress has frequently been interrupted for long periods by the pressure of routine work.

It was determined from the outset that it should be the aim of the Office to provide facilities for measurements to any degree of accuracy likely to be set even by the most exacting demands of modern science. The first steps taken by the Office consisted in working out a general plan and providing the most needed apparatus and facilities.

STANDARDS OF RESISTANCE.

To avoid the delay which would naturally arise from the construction of primary mercury standards, it was decided to refer all measurements of electrical resistance to the mean value of a number of wire coils, known in terms of the best existing mercury standards. The general excellence of coils of the Reichsanstalt type, the extremely small temperature coefficients and thermo-electromotive power with respect to copper of manganin and the permanency of coils of that material as shown by long continued observations at the Reichsanstalt, decided in favor of standards of the above description.

Four unit coils were purchased and were standardized at the Reichsanstalt where they were kept under observation for about one month, during which period they decreased in value by about .0015%. This, according to the maker, is the normal behavior of the material which undergoes, after the artificial aging, a small decrease in resistance followed by a slow increase. In addition to these coils the Office possesses two other coils of the same type purchased several years ago. Periodic intercomparisons between the old coils and the new ones will be made so that any relative changes will be made manifest, the two hardly having the same rate of change. Two new manganin coils have been ordered and are also to be referred to the German Standards. On their receipt, they will furnish us positive evidence in regard to any changes which may have taken place in the preliminary standards adopted. The approximate corrections at any time can then be determined by simple interpolation.

To fix this standard, the construction of a number of mercury copies will also be taken up. The construction of primary mercury standards, which is of fundamental importance, not only from a scientific standpoint but also on account of the legal questions which will surely arise, will be undertaken as soon as time permits.

The Office has acquired in addition to the unit coils, standards of the following denominations:

1	2	Ohm
1	5	"
4	10	"
4	100	"
3	1,000	"
2	10,000	"
2	100,000	"
3	0.1	"
3	0.01	"
3	0.001	"
3	0.0001	"

The temperature coefficients of these coils were first carefully determined, then the coils of the same denomination were intercompared and the observations reduced to differences at 20° C.

The next step consisted in determining the resistance of the multiples and submultiples in terms of the unit. Thus, two unit coils placed in series by means of a connecting link of known resistance were compared with the two ohm coil. The five and ten ohm coils were similarly evaluated in terms of the unit. From the known ratio of a 10 ohm coil to one of the units, the step can be made to the 100 ohm coils by means of a second ten ohm coil also known in terms of the unit. Similarly the values of the coils of still higher value were determined and those of the sub-multiples of the unit, by a slightly modified method.

THE METHOD OF COMPARISON ADOPTED.

The practice in this country and in England has been overwhelmingly in favor of the Carey Foster method, but the construction of the Reichsanstalt standards, with their terminals 16 cm. apart, makes the use of the Carey Foster Bridge almost out of the question. The design of a suitable bridge capable of comparing coils of this type with those having a different distance between the terminals, introduces still further complications. Moreover, in the Carey Foster method, additional resistances are introduced in the mercury cups of the commutator which are only eliminated in a perfect mechanical construction. Besides the resistances connecting the coils to the commutator, unless equal, are *not* eliminated. While the Carey Foster method is at first glance superior in being a zero method, the Wheatstone Kelvin Bridge, more simple and far less expensive in construction, excels the former especially where the intercomparison of low resistance standards is concerned, provided the coils to be compared are first made nearly equal by means of a shunt of known value applied to the greater. The value of the shunt need not even be known to a high degree of accuracy in case of fairly well adjusted coils.

The coils are connected to one another by copper forgings 1.5 cm. thick and 2 cm. wide, having therefore a resistance of about 0.6 micro-ohm per cm. of length, their terminals resting in mercury cups. To permit the comparison of coils differing widely from the standards, provisions have been made to enable one of the coils compared, to be placed in parallel with an accurately known coil by means of a second pair of mercury cups.

The sources of error characteristic of the direct deflection method are due to the following causes:

(1) Variation of E. M. F. of test battery.

(2) Variation of galvanometer sensibility, due either to the variation of proportionality between deflection and current, or to a change in the actual sensibility.

These only affect the deflection corresponding to the unbalanced *differences* in the ratios of the coils intercompared so that even if the errors in interpolation should be relatively large, the error in the ratio will be exceedingly small. With the ratios adjusted by means of shunts to within $\frac{100}{1000000}$ of equality an error of 1%, 5 to 10 times that actually existing, would produce an error of one part in 1,000,000 in the calculated ratio of the coils compared.

The Wheatstone-Kelvin bridge entirely eliminates the resistance of the parts connecting the lower mercury cups of these coils by means of shunting a second ratio coil across the resistance to be eliminated, the battery contact being transferred to its middle point. The inequality of the two halves of the ratio coil is eliminated by its reversal. The remaining sources of error are possible variable contact resistances in the mercury cups and possible differences in the insulation resistances between them. The bottoms of the cups are accurately surfaced and these sources of error are shown to have no importance by interchanging the positions of the two coils compared. Thermoelectromotive forces are eliminated by battery reversal. The heating effect of the test current was shown to be quite negligible, less than $\frac{1}{10000000}$ for a current of .03 ampere for one ohm manganin coils, since a current of 1 ampere through such a coil produces a heating of the coil above the temperature of the petroleum bath in which the comparisons are made, of approximately 1°C.

A specimen of the results which may be obtained under rather unfavorable conditions is given below. Four one ohm coils were intercompared in the 6 possible combinations, 6 additional measurements being made with the left and right coils interchanged with the following results:

L R	Observed Differences.	Cal. Diff.	Residuals Obs.-Cal.
L R	1402—1403 = —3.8 × 10^{-6} ohm	—3.8	0.0
R L	1402—1403 = —3.9		—0.1
L R	1402—1404 = —4.6	—3.7	—0.9
R L	1402—1404 = —2.8		+0.9
L R	1402—1405 = —0.8	—0.8	0.0
R L	1402—1405 = —1.0		—0.2
L R	1403—1404 = +0.2	—0.2	+0.4
R L	1403—1404 = —0.6		—0.4
L R	1403—1405 = +3.4	+3.0	+0.4
R L	1403—1405 = +2.5		—0.5
L R	1404—1405 = +3.4	+3.2	+0.2
R L	1404—1405 = +3.0		—0.2

Since resistance comparisons can be made to such a very high order of accuracy, to within $\frac{1}{500}$% at least, even in the case of properly designed .0001 ohm standards, all interested may assure themselves that every effort will be made by the Office to provide itself with primary standards of reference meeting the highest scientific requirements.

STANDARDS OF ELECTRO-MOTIVE FORCE.

The unit of electro-motive force, the volt, is legally defined as $\frac{1000}{1434}$ of the electromotive force of a Clark Standard cell at 15° C.

The official standards of electro-motive force for a government should obviously be, as far as possible, independent of any error due to impurities of the chemicals used. A large number of cells were set up with the purest commercially obtainable materials, from a number of independent sources. The work of purifying these materials by special methods was begun. Cells have also been set up with some of the purified materials, though much still remains to be done.

The intercomparisons so far made indicate a most satisfactory agreement of all the cells on hand, well within $\pm\frac{1}{200}\%$. The mean electro-motive force of the three dozen or more cells furnishes therefore a standard of reference which may be relied on within this limit. In addition to the Clark cells, a number of Cadmium cells, having considerable advantages over Clark cells, have been set up, but owing to lack of time no comparisons have as yet been made. New cells of both types are to be added from time to time, and intercompared with the old ones to determine whether any observable changes have taken place.

The relation which the E. M. F. of the Clark cell bears to that of the Cadmium cell will also be periodically determined, furnishing an additional check on the constancy of the standards of both types.

With an accurately calibrated potentiometer, and reliable standards of electromotive force the office is thus prepared to undertake the verification of direct current volt-meters and millivolt-meters.

MEASUREMENT OF ELECTRIC CURRENTS.

A grave mistake was made by the International Congress in concretely defining all three of the principal electrical units, the ohm, volt and ampere, which are necessarily connected by the fixed relation $C = \frac{E}{R}$. Hence only two of the definitions are independent, the chances being infinitesimal that the three definitions satisfy the relation between them on account of the relatively large errors in the absolute determinations on which they are based. Indeed, it already seems that the volt, as defined in terms of the Clark cell is in error by almost .1%.

Since the standards of resistance and electromotive force, as specified by the International Congress, are certainly reproducible within $\frac{1}{100}\%$, the unit of current intensity, defined as the current which will flow through a conductor of unit resistance, there being unit difference of potential between its terminals, would be fixed within the same limits of error.

Instead, it is defined in terms of the electro-chemical equivalent of silver. The voltametric measurement of a current is limited by the size of the apparatus available and is besides impossible under ordinary circumstances with the above accuracy.

Lord Rayleigh is of the opinion that his determination of the electro-chemical equivalent of silver may be in error by as much as $\frac{1}{10}\%$.

Retaining for the present the legal definitions of the ohm and volt, currents may be consistently measured by the fall in potential or potentiometer method, in terms of the specified standards of reference.

It is proposed to base all direct current measurements on these principles. With suitable low resistance standards for the measurement of heavy currents and with the set of Clark cells already on hand, the Office is prepared to undertake the verification of direct current ammeters within the limits practically set by the current generating apparatus on hand.

To summarize, the Office is therefore practically equipped for the verification of following classes of apparatus, viz:

Resistance Standards.—Coil of the following denominations: 1, 2, 5, 10, 100, 1000, 10,000 ohms.

Low Resistance Standards for current measurements of the following denominations: 0.1, 0.01, 0.001 and 0.0001 ohms.

Resistance boxes.

Potentiometers.

Ratio coils.

Standards of Electro-motive Force.—Clark standard cells and other standard cells.

Direct Current Measuring Apparatus. Millivoltmeters and voltmeters up to 150 volts.

Ammeters up to 50 amperes.

For the verification of direct current measuring apparatus of even moderate range, the present facilities of the Office are entirely inadequate, although now-a-days potential differences up to 20,000 volts and currents of 20,000 amperes are met with in actual practice.

Provision must also be made for the calibration of Wattmeters and Energy meters.

The verification of alternating current measuring apparatus requires further facilities, and in view of the ever increasing importance of alternating current systems, such facilities should be provided without delay.

The verification of Condensers and Self Induction Standards also merits attention.

Another question, practically related to electrical measurements, is the photometry of arc and incandescent lamps.

Preliminary steps have already been taken by the American Institute of Electrical Engineers, looking forward to the coöperation of the office in the official verification of incandescent lamps as secondary photometric standards to enable even the moderate consumer to procure reliable standards at a reasonable rate.

The measurement of high and low temperatures will also be taken up, a knowledge of the exact thermal conditions under which certain industrial operations are conducted being of the utmost practical consequence.

There are two most reliable electrical methods based respectively on the variations of electrical resistance and of thermo-electromotive force with the temperature. Hence, with standards of electromotive force and resistance available, this subject is brought within easy reach.

No claim of originality is made in what has been accomplished. The magnificent work of the Physico-technical Reichsanstalt at Berlin with its staff of scientific and technical assistants and in its almost unlimited resources has been of the greatest help. It has set such a high standard of excellence that it will require years for similar bureaus, which will surely be organized by other governments, to attain.

FRANK A. WOLFF, JR.
U. S. OFFICE OF STANDARD
WEIGHTS AND MEASURES.

THE ESTABLISHMENT OF A NATIONAL UNIVERSITY.*

THE sub-committee appointed November 3, 1899, beg leave to submit the following report:

The resolution of reference to the sub-committee was as follows:

"That a sub-committee be requested to prepare for consideration by the full committee a detailed plan by which students who have taken a baccalaureate degree, or who have had an equivalent training, may have full and systematic advantage of the opportunities for advanced instruction and research which are now or may hereafter be offered by the Government; such a plan to include the coöperation with the Smithsonian Institution of the universities willing to accept a share of the responsibility incident thereto.

"It is understood that the financial administration of this plan should be such that whether or not Government aid be given, there shall be no discouragement of private gifts or bequests.

"It is understood that the scope of this plan should be indicated by the governmental collections and establishments which are now available, or as they may hereafter be increased or developed by the Government for its own purposes."

The undersigned members of the sub-committee have been in active correspondence and conference on the matters referred to them. They have made several visits to Washington, and have had the advantage of hearing the views of representative Regents of the Smithsonian Institution and those of the directors of the scientific bureaus of the Government. In particular, they have profited by consultations with representatives of the American Association of Agricultural Colleges and

* Report of the sub-committee appointed November 3, 1899, to the Committee of the National Educational Association, appointed July 7, 1898, to investigate the entire subject of the establishment of a National University.

Experiment Stations, which body has had before it for some time past a project for the utilization, for graduate students, of the resources of the Departments at Washington.

The sub-committee are of opinion that the general plan of action now under discussion by this committee has secured, and will command, the active support of the directors and administrators of the Government's scientific work as well as that of the educational institutions of the country. It is very generally accepted as the best possible way of meeting what is reasonable in the demand for the establishment of a national university. The success of the plan, however, will depend upon the wisdom with which its details are first formulated and then administered.

Fortunately, the Congress of the United States has already declared it to be the policy of the Government to encourage the use of the scientific collections at Washington by properly qualified students, for purposes of research. This was done by Joint Resolution, April 12, 1892, which reads as follows:

Joint resolution to encourage the establishment and endowment of institutions of learning at the national capital by defining the policy of the Government with reference to the use of its literary and scientific collections by students:

Whereas, large collections illustrative of the various arts and science and facilitating literary and scientific research have been accumulated by the action of Congress through a series of years at the national capital; and

Whereas, it was the original purpose of the Government thereby to promote research and the diffusion of knowledge, and is now the settled policy and present practice of those charged with the care of these collections specially to encourage students who devote their time to the investigation and study of any branch of knowledge by allowing to them all proper use thereof; and

Whereas, it is represented that the enumeration of these facilities and the formal statement of this policy will encourage the establishment and endowment of institutions of learning at the seat of Government, and promote the work of education by attracting students to avail themselves of the advantages aforesaid under the direction of competent instructors: Therefore,

Resolved by the Senate and House of Representatives of the United States of America, in Congress assembled, That the facilities for research and illustration in the following and any other Governmental collections now existing or hereafter to be established in the city of Washington for the promotion of knowledge shall be accessible, under such rules and restrictions as the officers in charge of each collection may prescribe, subject to such authority as is now or may hereafter be permitted by law, to the scientific investigators and to students of any institution of higher education now incorporated or hereafter to be incorporated under the laws of Congress or of the District of Columbia, to wit:

One. Of the Library of Congress.
Two. Of the National Museum.
Three. Of the Patent Office.
Four. Of the Bureau of Education.
Five. Of the Bureau of Ethnology.
Six. Of the Army Medical Museum.
Seven. Of the Department of Agriculture.
Eight. Of the Fish Commission.
Nine. Of the Botanic Gardens.
Ten. Of the Coast and Geodetic Survey.
Eleven. Of the Geological Survey.
Twelve. Of the Naval Observatory.
Approved, April 12, 1892.

The express purpose of this joint resolution is to encourage the foundation of institutions at Washington which may take advantage of the collections and facilities enumerated. This resolution affirms and establishes the principle which must underlie any such plan for a School or Bureau of Research as this Committee now has before it.

The governmental collections and establishments having been declared available for research, the next question is as to the systematic organization of the work to be carried on and the proper oversight of the persons engaged in making investigations. At this point certain practical difficulties must be met.

These collections and establishments are under widely different jurisdictions. Some of them are attached to the Executive Departments, others are independent of any control but that of the Congress. Some of them are adequately equipped and well housed, others are most inadequately provided for. To wait for the reorganization of the scientific work of the Government in systematic fashion, is to postpone indefinitely the question of taking advantage of the opportunites which the Government has to offer. In the view of your sub-committee therefore, it is essential, in any plan which may now be adopted, that no attempt be made to alter the existing status of the Government's scientific work; that is a large undertaking, for which time and further experience are necessary. The conditions at Washington must be accepted just as they are. The head of each Bureau or Division which can offer any facilities for research, should be asked to state, in detail, just what those facilities are, how many persons can be received, and under what limitations or conditions. It would be one of the functions of any administrative officer who might be charged with the oversight of a School or Bureau of Research, to make these facilities known, as well as to exercise supervision over the students who avail themselves of them.

The resolution of reference contemplates the active coöperation of the Smithsonian Institution in the conduct of the proposed School or Bureau. The attitude of the governing board of the Smithsonian towards the undertaking, becomes then a matter of great importance. What this attitude is we are able to learn from the action taken by the Regents of the Smithsonian Institution at their annual meeting, held January 24, 1900, upon a communication from the American Association of Agricultural Colleges and Experiment Stations, which asked for the organization of a Bureau of Graduate Study in Washington under the supervision of the Smithsonian. The report of the committee to which the communication had been referred, contained this language:

"The committee does not hesitate to express its warm and decided sympathy with the general purpose of the movement thus made by the associated colleges. The object sought commends itself to us all, and the zeal and ability with which it has been pressed upon our consideration by the very able and distinguished educators and scientists connected with these colleges furnish ample assurance that the consummation of the great and leading object sought by them is only a question of time. The material already collected in the bureaus and departments of the government furnishes a rich mine of educational wealth that will not be permitted to remain forever undeveloped. This material is now being constantly enriched by the most valuable additions to its present enormous wealth. Already it has invited to the national capital many distinguished scientists, anxious to avail themselves of the superior advantages thus offered for investigation and research.

"Your committee, however, is painfully impressed with the fact that the powers of the Smithsonian Institution as at present organized are scarcely broad enough to embrace the work proposed. And the committee is equally impressed with the fact that even with enlarged authority its present financial condition would absolutely prevent anything like efficient and creditable performance of the work contemplated.

"It is well known to the members of this board that a great wealth of material—material which would be of immense utility in the successful accomplishment of the purposes indicated by the associated colleges—lies buried in the crypts and cellars of the National Museum.

"If our institution is unable for want of room, as it undoubtedly is, even to place this valuable material on exhibition for the public eyes, and as little to arrange it for scientific uses, the problem of providing halls for lectures and meeting the necessary expenditures incident to the work proposed becomes serious and formidable in the extreme. Your committee is not prepared to make definite recommendations to the board for its final or ultimate action. That which is clearly inexpedient to-day may become not only expedient but eminently desirable to-morrow."

It is felt by the Regents of the Smithsonian Institution that their present powers are hardly broad enough to embrace educational work, and also that it is doubtful whether the Congress has power, under the Constitution, to appropriate money, raised by taxation, for purposes of education. In view of the past construction of the 'general welfare' clause of the Constitution, and in view of the fact that the Smithsonian Institution was established 'for the increase and diffusion of knowledge among men,' your sub-committee are unable to share these doubts.

At the same meeting of the Regents of the Smithsonian Institution to which reference has been made, Mr. Alexander Graham Bell introduced the following resolution, which is to be the subject of consideration at a later meeting:

"In order to facilitate the utilization of the government departments for the purposes of research, in pursuance of the policy enunciated by Congress, in a Joint Resolution approved April 12, 1892:

Resolved, That Congress be asked to provide for an Assistant Secretary of the Smithsonian Institution in charge of Research in the Government Departments, whose duty it shall be to ascertain and make known what facilities for Research exist in the Government Departments, and arrange with the heads of departments, and with the officers in charge of Government Collections, rules and regulations under which suitably qualified persons may have access to the Government collections for the purposes of Research, with due regard to the needs and requirements of the work of the Government; and it shall also be his duty to direct the researches of such persons into lines which will promote the interests of the government, and the development of the natural resources, agriculture, manufactures, and commerce of the country, and (generally) promote the progress of science and the useful arts, and the increase and diffusion of knowledge among men."

Should the Regents decide to adopt this resolution, and should the Congress act favorably upon the request which it contains, a Bureau of Research would be established competent to do the work which this committee have in mind.

In this way all of the ends which this committee has deemed desirable, would be accomplished—save one. That one your sub-committee believe to be of the highest importance. It is the co-operation of the universities and colleges of the country in carrying on such systematic research work as is contemplated. That such co-operation should be provided for, by the constitution of an advisory board or in some other way, your sub-commtttee deem essential, not only in the interest of the work itself, but also in that of the universities and colleges. That they would be greatly benefited by the new stimulus which would come from united effort in assisting to conduct such research work as is proposed, is certain.

An alternative plan is worthy of careful consideration. This is to make the Bureau of Education, instead of the Smithsonian Institution, the administrative center of the Bureau of Research. To accomplish this would involve, perhaps, the long-desired erection of the Bureau of Education into a separate department, on a plane with the Department of Labor, and the provision of an appropriate salary for the Commissioner instead of the pittance of $3000 now allowed. The executive head of the Bureau of Research might then be an assistant Commissioner of Education at a salary of $4000 or $4500. One marked advantage of this plan is that the intellectual outlook of the Bureau of Education is likely to be broader than that of the Smithsonian Institution, as the Bureau is in close touch and active correspondence with all the educational institutions of the country, and not merely with those whose main or sole interest is in the field of the natural sciences.

If it is decided that the initiative in this undertaking shall lie with the Regents of the Smithsonian Institution, then your sub-committee are prepared to recommend the following course of action:

1. That the Regents of the Smithsonian Institution be requested to ask the Congress of the United States for a special appropriation for the work of research and investigation, to be conducted under their supervision by persons properly qualified therefor. Such work to be so conducted as to utilize the libraries, scientific collections, apparatus and laboratories owned

by the United States and in charge of officers of the United States, for investigations and researches, under regulations to be prescribed by the said Regents, and as far as shall be mutually agreed upon between the said Regents and the heads of the several executive departments of the Government, the Librarian of Congress, Commissioner of Labor, Commissioner of Fish and Fisheries, and the Secretary of the Smithsonian Institution, with a view of carrying out the policy of Congress, declared in the Joint Resolution of April 12, 1892.

2. That the Regents be requested to ask the general public for gifts of money, to be used in providing buildings, laboratories, equipment and endowments, for purposes of instruction, such instruction to be limited to students who are graduates of properly accredited institutions, or those who are otherwise properly qualified, it being understood that it shall not be the purpose of the Smithsonian Institution to confer degrees of any kind in connection with such instruction.

3. That the Regents be requested to formulate a plan for the appointment of an Advisory Board ; the members of said Board to represent the leading educational institutions of the country, with a view to securing the active co-operation of the colleges and universities of the country in carrying on this undertaking.

If, however, it is decided that the Bureau of Education is the best administrative center for this work, then we recommend the following course of action :

1. That the Congress be requested to erect the Bureau of Education into an independent department, on a plane with the Department of Labor, and to provide a salary of not less than $5000 for the Commissioner of Education

2. That the Congress be requested to provide for an Assistant Commissioner of Education, at a salary of not less than $4000, whose duty it shall be to ascertain and make known what facilities for research exist in the government departments and collections at Washington ; to formulate, in connection with the heads of the several departments and the officers in charge of Government collections, rules and regulations under which suitably qualified persons may undertake research in those departments and collections, with a view to carrying out the policy of Congress as declared in the joint resolution approved April 12, 1892 ; and to exercise general supervision over the persons permitted to undertake such research.

3. That the Department of Education, so organized, be requested to formulate a plan for the appointment of an advisory board, representing the colleges and universities of the country which receive aid from the government or which have not fewer than 25 resident graduate students in any one year, with a view to securing the active co-operation of such colleges and universities in organizing and maintaining the work of research at Washington.

4. That in accordance with a plan to be prepared and adopted by the Department of Education, in consultation with such advisory board or its executive committee, the colleges and universities of the country be asked to give credit, toward the requirements for their higher degrees, for research carried on at Washington under the supervision of the Department of Education.

Under the terms of either of the plans proposed it is assumed that the persons admitted to carry on research will be graduates of a college or university in good standing, or will have had an equivalent training.

Such a bureau of research, whether it be placed under the care of the Smithsonian Institution or under that of the Department of Education—which would supersede the existing Bureau of Education—would be a source of strength to the higher education of the United States and a great advantage to the Government in its work of promoting the progress of science and the useful arts, and in applying the result of scientific investigation to the development of the natural resources of the country, of agriculture, of manufactures, and of commerce.

We regret that our colleague, Dr. J. L. M. Curry, has, through absence from home, been prevented from sharing in the formulation of this report.

Respectfully submitted,

William R. Harper,

Nicholas Murray Butler.

Chicago, Ill.,
Feb. 26, 1900.

ASSOCIATION OF AMERICAN ANATOMISTS.

The Association held its twelfth session December 27 and 28, 1899, at New Haven, Connecticut, in conjunction with the affiliated societies. There were present nineteen members:—Blake, Ferris, Gerrish, Herrick, Holmes, Hrdlicka, Huber, Lamb, Mackenzie, Mall, Mellus, Miller, M. B. Moody, R. O. Moody, Minot, Piersol, Tuttle, Shepherd, and Wilder. New members were elected as follows:—R. Tait Mackenzie, B.A., M.D., Demonstrator of Anatomy, McGill University, Montreal, Canada, No. 59 Metcalfe St., Montreal; E. Linden Mellus, M.D., Fellow in Anatomy, Johns Hopkins University, Baltimore, Md., No. 10 East Chase Street, Baltimore; Wm. S. Miller, M.D., Assistant Professor of Vertebrate Anatomy, Wisconsin University, Madison, Wisconsin, 615 Lake Street, Madison; Alexander Primrose, M.B.C.M. (Edin.), M.R.C.S. (Eng.), Professor of Anatomy, University of Toronto, Canada, 100 College Street, Toronto; Richard Dresser Small, A.B, M.D., Instructor in Anatomy, Portland School for Medical Instruction, 606 Congress Street, Portland, Maine. Dr. John Cleland of Glasgow, Scotland, was elected an honorary member. Dr. Frank Baker resigned from the Committee on Anatomical Nomenclature and Dr. H. B. Ferris was appointed to fill the vacancy. The annual dues were increased to five dollars. It was decided to meet as usual with the Congress of American Physicians and Surgeons this spring. The Association voted that members desiring to subscribe for the *Journal of Anatomy and Physiology* could do so through its Secretary at net cost of $5.30; also that the titles of papers to be read at meetings should be accompanied by abstracts of about 150 words each. Officers for the ensuing term were elected:—Dr. George S. Huntington, New York City, President; Dr. F. H. Gerrish, Portland, Me., First Vice-President; Dr. G. C. Huber, University of Michigan, Second Vice-President; Dr. D. S. Lamb, Washington, Secretary and Treasurer; Dr. C. S. Minot, of Boston, member of the Executive Committee in place of Dr. Gerrish, retired.

In the absence of Drs. Huntington and Spitzka, the Committee on Anatomical Nomenclature (Drs. Gerrish, Wilder and Ferris) reported progress and asked the Association to consider, with a view to decisive action at the next session, the following names for constituents of the peripheral nervous system. Where a single term is given it is the one adopted by the B. N. A., and also preferred unanimously by the Committee. Where two terms are used the first is the one in the B. N. A., but this does not imply that it is preferred by the Committee.

Nervi cerebrales vel craniales.

Nervi olfactorii,
Nervus opticus,
" oculomotorius,
" trochlearis,
" trigeminus *vel* trifacialis,
  Nervus ophthalmicus,
  " maxillaris,
  " mandibularis,
Nervus abducens,
" facialis,
" acusticus *vel* auditorius,
" glossopharyngeus,
" vagus,
" accessorius,
" hypoglossus.

Nervi spinales.

Nervi cervicales,
  Plexus brachialis,
    Nervus musculocutaneus,
    " medianus,
    " ulnaris,
    " radialis.
Nervi thoracales,
" lumbales,
" sacrales,
Nervus coccygeus,
Plexus lumbalis,
" sacralis,
    Nervus iliohypogastricus,
    " ilioïnguinalis,
    " genitofemoralis (genitocruralis),
    " obturatorius,
    " femoralis (cruralis anterior),
    " ischiadicus *vel* sciaticus.

Systema nervorum sympathicum.

Truncus sympathicus,
Ganglia trunci sympathici,
Plexus sympathici,
Ganglia plexuum sympathicorum.

The address of the President, Dr. Wilder, was entitled, 'Historic, ethical and practical considerations respecting the names and numbers of the definitive encephalic segments.' There were presented facts and arguments in favor of maintaining the customary method of enumerating the segments of the brain beginning with the most cephalic or 'anterior,' and in favor of retaining for five of these segments the names, *prosencephalon*, *diencephalon*, *mesencephalon*, *epencephalon* and *metencephalon*, which were adopted or proposed in 1867 by the editors of the seventh edition of 'Quain's Anatomy.' In particular it was shown that the replacement of *metencephalon* by 'myelencephalon' for the last (oblongatal) segment, as done by Huxley and in the B. N. A., is not only unjustifiable on historic and ethical grounds, but practically objectionable because it apparently involves the retention of the lengthy and unrelated terms of the B. N. A., viz: 'myelencephalon,' 'ventriculus quartus,' 'tela chorioidea ventriculi quarti,' 'plexus chorioideus ventriculi quarti,' and 'apertura medialis ventriculi quarti' (foramen Magendii), and the abandonment of the series of correlated single-word terms, *metencephalon*, *metacoelia*, *metatela*, *metaplexus* and *metaporus*. (The address will be published in SCIENCE.)

The following papers were read:

Divisions of cranial bones in man and animals: DR. ALES HRDLICKA, of New York City.

Five classes of divisions are described and demonstrated, namely: (1) results of fractures; (2) normal, partial divisions in definite locations in the bones of the embryos and new-born; (3) anomalous partial divisions consequent upon the formation of a foramen in the ossifying bone; (4) divisions due to a retardation of the union of any of the normal segments of the bones; and (5) anomalous divisions due to an abnormal multiplicity of the centers of ossification. Class (2):—Two of the most prominent and constant of such divisions in man are the parietal incisure of Broca, and a squamous suture situated near the middle of the occipital border of the parietal bone (termed 'parietal suture' by the author). Class (3):—Rare in man, so far as the bones of the cranial vault are concerned, but are common in the human superior maxillæ in connection with the infraorbital foramen; they are very frequent in the parietal and temporal bones in mammals, particularly in the herbivora. Class (5):—Occur generally in the form of sutures dividing the whole bone or separating one of its angles. They are liable to be confounded with the previous and are somewhat allied to the same. These divisions are well known in the human parietal; the author has the records of eighteen new cases, found principally in macaques; one of the specimens presented before the Association shows a bilateral division of the parietal bone in a chimpanzee. In lower mammals these divisions are extremely rare.

A further contribution to the study of the tibia, relative to its shapes (vide last year's Proceedings of the Association): DR. ALES HRDLICKA.

An effort has been made during 1899 to learn the occupations of the subjects whose tibias had been examined. The returns show a great diversity of occupations and even of classes of occupations, and it is plain that if any definite conclusions are to be reached, the investigations must extend over at least another thousand of subjects. The main indications so far are as follows: Inactivity of the lower extremities favors the persistence of the adolescent shape of the tibiæ; considerable activity in the lower limbs especially if of a definite kind, favors a differentiation in the shape of the bones. In the American Indians who were always great walkers and did otherwise comparatively but little, types two and four of tibiæ prevail. In strong, but also in rachitic, individuals there is an inclination to type 3 of the bones. There was but little occasion to inquire into the influence of heredity on the shape of the tibiæ, nevertheless such influence seems very probable.

The deep fascia: DR. HOLMES, University of Pennsylvania.

The deep fascia is a firm tense membrane of wide extent and complex function. It lines the interior of the abdomen, protects the various orifices, forms ligaments for the organs and a floor for the pelvis, sheathes vessels and muscles and binds muscles into groups, divides regions into spaces and sets off organs by themselves, so that differentiation into fascial compartments means also differentiation into function. The transversalis fascia is a continuation of the fascia-lata and forms a fibrous bag for the abdomen continuous posteriorly with the lumbar fascia. It is the real pelvic floor rather than the levator ani muscle. The subdivisions of the muscles of the thigh, leg and foot, and of the axilla, arm, forearm and hand indicate the separate office of each group. In the cervical region the three divisions of investing, pretracheal, and prevertebral, indicate similar conditions; the prevertebral layer being of especial value in conserving the action of the esophagus, larynx and trachea. The especial object of the paper is to direct the attention of the members of the Association to the greater importance of the fascia, and also to maintain that whenever we find its distribution separating the structures, we may regard it as an indication of an equal separation into a distinct function.

The facial expression of fatigue and violent effort: DR. R. TAIT MCKENZIE, McGill University.

In fatigue, as observed in a foot-race of a mile, we see the following changes: The lips are slightly parted, the teeth open, eyes semi-closed, brows contracted, as in mental concentration, the upper half of the orbicularis acting with the corrugator supercilii. As the race proceeds, the lips are drawn down by the depressors and up by the levator proprius and zygomaticus minor. The corrugator acts strongly. As the respiratory need increases, the nostrils are dilated by the levator labii superioris alæque nasi, accentuating the expression of grief. This expression then passes away and the face becomes apathetic, the mouth gapes and the jaw drops, the upper eyelid tends to droop. The lowering of the upper lid is counteracted either by throwing the head back, or by bringing into action the occipito-frontalis. This give rise to an expression of astonishment in the upper part of the face. In extreme exhaustion or collapse, the jaw drops, the upper lid comes down, the face becomes expressionless. When a violent effort is made the expression comes more nearly to correspond to rage.

A note on the relation of the external carotid artery: DR. WM. KEILLER, of Texas.

Text-book descriptions of the relation of the external carotid (with the exception of Cunningham's description in his 'Dissector's Guide') are incorrect: (1) In describing the ramus of the jaw as an internal relation when it is really external. (2) The structures described in text-books as lying in front are really external. (3) The statements as to its relations to the parotid gland are misleading. (4) It is at first anterior, and slightly internal to the internal carotid, then winds backwards and outwards till it lies on its outer side. (5) Most of the structures described as lying behind it are internal.

How best to teach anatomy to the third year medical students: DR. KEILLER.

Brief sketch of a course of dissections of direct surgical and medical interest, and leading up to an operative course, being the third year's course of practical anatomy at the University of Texas.

The anatomy of the anal region : DR. KEILLER.

Careful description of the relations of the levator ani, external and internal sphincter, the radicles of the hemorrhoidal veins, and the bearing of these facts on operations for piles and on the pathology of ischiorectal abscess.

On a hitherto unrecognized form of vertebrate blood circulation in organs without capillaries: DR. MINOT, Boston.

Non-development of the left heart and closure of the aortic valve, depending upon an error in the development of the auricular septum : DR. BLAKE, New York City.

The child from which the specimen was taken lived four days. It presented no other abnormalities. It was cyanotic and died of cardiac failure. The right chambers of heart, the pulmonary artery and ductus arteriosus are very large. The left chambers are very small. The aortic opening is closed by a fibrous septum consisting of the fused valves. The ascending aorta is only of sufficient caliber to supply the coronary arteries. The eustachian valve is rudimentary.

The valve of the foramen ovale is developed in the right auricle so that fluids can only pass from the left to the right auricle. This arrangement of the valve can be explained by the method of development of the auricular septum, as described by Born in rabbit embryos, if we presume an overgrowth of the septum secundum and an insufficient development of the primary septum. The interest of the specimen lies in the generalization of the application of Born's theory of development. The left ventricle receiving no blood, the aortic valves were kept closed by back pressure and fused. No similar anomalies could be found recorded.

The delimitation of the divisions of the large intestine according to intrinsic features : DR. GERRISH.

The argument made is that the segment variously called sigmoid colon, sigmoid flexure, iliac colon, and omega flexure, should include all of that part and only that part of the large intestine, caudad of the crest of the ilium, which has a mesentery. This plan would subtract a little from the cephalic portion of the sigmoid colon, as generally accepted now, and would add to its caudal portion making the rectum begin at the third sacral vertebra.

The normal capacity of the human bladder : DR. GERRISH.

This question can be answered by physiologic tests only. The normal capacity is not shown by the amount of fluid which the viscus can possibly contain without rupture or even by that which it occasionally holds without appreciable harm. But it can be determined by ascertaining the average amount of urine secreted in 24 hours and the average number of micturitions in the same time. By this method the capacity is found to be not much in excess of 250 grams (8 oz.) : one-half that usually stated.

Observations on sensory nerve fibers in the visceral nerves, with remarks on their mode of termination : DR. HUBER.

That relatively large medullated nerves end in the viscera we know from the observations of Gaskell, Langley and Edgeworth, and from the more recent investigations of numerous observers who have investigated the sympathetic nervous system or the innervation of the viscera with the aid of the Golgi or methylin blue methods. That these relatively large medullated nerves terminate either in special end-organs, Pacinian corpuscles, encapsulated nerve-endings of Timofew, etc., or in free sensory endings, seems also well established. The writer proposes to draw attention more especially to the free sensory endings in viscera, and to emphasize the following points: (1) the repeated division of such sensory nerves before losing their medullary sheaths; (2) the relatively large number of arborizations in which such nerves terminate; and (3) the fact that they terminate in the mucosa and epithelium lining the hollow organs and ducts.

Sensory nerve terminations in the tendons of the extrinsic eye muscles of the cat: DR. HUBER.

Marchi, Ciaccio and Sherrington have shown that medullated nerve fibers terminate in the tendons of the extrinsic eye muscles of a number of mammals. These nerves are looked upon as sensory nerves, although, as Sherrington has shown, not branches of the ophthalmic division of the trigeminus. In the cat the nerves ending in the tendons of the extrinsic eye muscles do so in terminations which differ in structure from the neuro-tendinous endings found in other skeletal muscles of this animal. The medullary nerves which terminate in the eye muscles of the cat lose their medullary sheaths just before reaching their destination and end in a network of varicose fibers, which network surrounds the tendon fasciculi just distal to the insertion of the muscle fibers. Each tendon fasciculus surrounded by such a plexus is enclosed within a thin, closely fitting, fibrous sheath.

Comments upon the figure of the mesal (median) aspect of a human brain as published by His and reproduced by him and others: DR. WILDER.

"In the *Archiv für Anatomie* for 1893, Professor His published a figure of the mesal aspect of an adult human brain; it was reproduced on p. 76 of the protocols of the B. N. A., and in the B. N. A. itself, *Archiv für Anat.*, 1895, Suppl. Band., p. 161, but is there stated (evidently through inadvertence) to represent a fetal brain of the third month. The figure has been reproduced without comment by Van Gehuchten (second edition) and Barker ('The Nervous System,' 1899, Fig. 92). Even if designed merely as a diagram in illustration of its author's views of the definitive segments, and even if many teachers and investigators are so well informed as not to be misled by its errors of omission and commission, certain features are certain to cause serious and wide-spread misapprehension. Twenty such features were specified. The most important exemplify the general defect of such figures in most manuals, viz., incomplete circumscription of the cavities, and inadequate demarcation of the cut surfaces from the natural (pial or endymal). In these respects anatomists may well imitate the accuracy of Reichert ('Der Bau des menschlichen Gehirns,' 1859–61), although his figures are not absolutely perfect.

If an 'Isthmus Rhombencephali' why not an 'Isthmus Prosencephali'? DR. STROUD, Cornell University.

"In the early fetal brain of man, the cat, and perhaps some other mammals, there is a necklike region just caudad of the mesencephal. Professor Wilhelm His names this region 'Isthmus Rhombencephali,' and apparently regards it as coördinate with the other five definitive segments recognized by him (*Archiv. für Anatomie,* 1893, 173–174; 1895, Suppl. Bd. 'B. N. A.,' 157). But in these same specimens, and in many of the figures published by His in the *Archiv* for 1892 and 1893, and in 'Die Entwickelung des menschlichen Rautenhirns,' 1891, there is another necklike region cephalad of the mesencephal quite as distinct and sometimes more so. A schema of encephalic segmentation should be consistent, and while not denying the possibility that one or both of these regions may represent a primitive neuromere, it seems reasonable to conclude that, taking into account the adult and developmental conditions in vertebrates generally, probably neither should be regarded as a definitive segment.

The basis and nature of a schema of the definitive encephalic segments: Dr. Wilder.

"A satisfactory definition of 'Definitive Encephalic Segment' has not yet been framed, but the best example is the Mesencephalon (crura and quadrigeminum). Although developed from one 'vesicle,' this apparently includes at least two of the 'neuromeres or primitive segments.' Many points are still undetermined. Some were discussed in 1897 in 'What is the Morphologic Status of the Olfactory Portion of the Brain?' Others are indicated among the fifty 'Questions as to the Segmental Constitution of the Brain'; copies of the seven mimeographed sheets bearing these 'questions' were distributed at the meeting and will be sent to those interested. The following conclusions are regarded as sound:—The provisional schema of the definitive segments should be based upon adult rather than developmental conditions. The definitive segments need not be structurally or developmentally identical. They need not coincide with either, (*a*) the primitive neuromeres, or (*b*) the primary encephalic vesicles, (*c*) the secondary vesicles. No species or group should be ignored. The presumption is in favor of generalized forms, and not in favor of forms merely because they are available for other purposes. When both naturalness and convenience are taken into account, the best provisional schema corresponds mainly with the one indicated in the table on p. 29 of the Proceedings of this Association for May, 1897."

Is neuron available as a designation of the central nervous system? Dr. Wilder.

"Neuron (from τό νεῦρον) was proposed by me in this sense in 1884 (*N. Y. Med. Jour.*, Aug. 2, p. 114), and employed in the same Journal, March 28, 1885, p. 356; in addresses before the Amer. Neurol. Assoc.; (*Jour. Nerv. and Ment. Dis.*, July, 1885); *Amer. Asso. Adv. Sci. Proceedings*, 1885, and in the second edition of 'Anatomical Technology,' 1886. It has been adopted by McClure, Minot, Waters and others. The reasons for its abandonment in 1889 for *neuraxis*, as stated in the Proceedings of this Association for 1895, p. 44, and Ref. Handbook of Med. Sci., IX., 100, now seem to me inadequate. *Neuron* is the basis of *neural* (as applied to aspect, folds, furrow, and canal) and of *neurenteric* and other compounds, and it is the natural correlative of *enteron* (entire alimentary canal) and of *axon* (notochord or primitive skeletal axis). Not until 1891 did Waldeyer propose *neuron* for the nerve-cell and its processes; not until 1893 did Shafer apply it to the axis-cylinder process. As with *tarsus* and *cilium* the context would commonly avert confusion between the macroscopic and microscopic significations of the word in a given case. The compounds *macroneuron* and *microneuron* might be employed if necessary, or (as suggested by Barker, p. 40), the histologic element might be designated by *neurōne*, as if from νευρών. Note.—The question is now further complicated by Van Gehuchten's adoption of 'Neuraxe' as the title of a new journal of neurology.

Polydactylism and Syndactylism: Dr. Shepherd, of Montreal.

Dr. Shepherd showed a series of skiagrams and photographs illustrating some of the deformities of the digits which he had met with. The first case was that of a young man aged 21, who had six digits on each foot and hand, and they were so arranged that the deformity would not be noticed unless attention was especially attracted to it; there was a gradual diminution in the size from the middle finger to the supernumerary little digit (post minimus). His paternal greatgrandfather had supernumerary digits, as had a paternal uncle, and this uncle's children had supernumerary digits. Two of his own brothers and two of his sisters had a like conditions as well as his sisters' and brothers' children. In another case also there was a hereditary history for some generations on the father's side. Another case was stated and the photographs shown where, in a man aged 22, there was no thumb on the left hand and only a very rudimentary one on the right hand; no history of heredity. Another, where there was absence of the thumb of right hand and a rudimentary little finger with absence of the fifth metacarpal bone. The father had a similar deformity. A remarkable skiagram was exhibited which showed a fusion anteriorly of the proximal phalanges of the middle and ring fingers, and a complete fusion of the middle and distal phalanges of these fingers; also a case of fusion of the ring and middle fingers of the right hand in a boy age 20. In neither case was there any history of heredity. In the case of polydactylism, Dr. Shepherd thought some of the cases might be due to reversion, but the majority he thought were probably the result of dichotomy.

D. S. LAMB,
Secretary.

SCIENTIFIC BOOKS.

Kongl. Svenska Vetenskaps-Akadamiens Handlingar, Bandet 31. No. 5. Rhopalocera Æthiopica. Die Tagfalter des Æthiopischen Faunengebietes. Eine Systematisch-Geographische Studie. CHR. AURIVILLIUS. Pp. 571. Six chromo-lithographic plates containing 50 figures. Numerous figures in the text. Large 4to. Stockholm, 1898.

Without the aid which learned societies are sometimes able to supply, important works, like the Rhopalocera Æthiopica of Professor Aurivillius, would not often see the light. The demand for such treatises is restricted, being largely confined to specialists, and the expense of producing them is necessarily very great. For many years the learned author has been gathering the material for his undertaking, which having been completed, was laid before the Royal Academy of Sciences in Stockholm on the 10th of June, 1898. The work was issued from the press in June of 1899.

After a brief introduction the author defines the limits and subdivisions of the Ethiopian Region, closely following Wallace, Sclater and others, and excluding the regions immediately bordering upon the Mediterranean from consideration, because the fauna of the northern coast-lands is distinctly palæarctic, and including southern Arabia, the tropical islands, and Madagascar.

This chapter is followed by a bibliography of the subject, arranged according to the political subdivisions of the region. The list of books and papers, while extensive, is, nevertheless, not as complete as might be desired, a number of titles having been apparently overlooked in preparing the bibliography, although in most cases they are subsequently referred to in the text.

The systematic position of the Rhopalocera is next discussed. The author follows Haase and E. Reuter in excluding the Hesperiidæ from the Rhopalocera, regarding them as an independent group, the *Grypocera*, of equal value with the butterflies, and intermediate between them and the moths, or Heterocera. In this view, he will probably find few followers, although a good deal may be said in favor of such a procedure. The Hesperiidæ are accordingly excluded from consideration in the treatise, which enumerates sixteen hundred and thirteen species of Rhopalocera, in this restricted sense, as occurring in the Ethiopian region. Of these species thirty-three, or 2.04 per centum of the whole, also occur in other faunal regions. If we include the Hesperiidæ enumerated by the present writer in his 'Synonymic Catalogue of the Hesperiidæ of Africa and the Adjacent Islands,' published in the Proceedings of the Zoological Society of London in 1896, to which some twenty or more species, described since then must be added, we have a total of nineteen hundred and eighty, or, in round numbers, two thousand species of Rhopalocera in the usually accepted sense of the term occurring in the Ethiopian region. Further explorations are likely to bring to light many species as yet unknown, and the student who is familiar with the subject will see that this is from the standpoint of the lepidopterist one of the richest regions on the globe, the number of species greatly exceeding that represented by the butterfly-faunæ of the Palæarctic and Nearctic regions combined. In extra-tropical North America there occur about six hundred and fifty species, and in Europe and extra-tropical Asia together not more than seven hundred species all told.

A chapter is devoted to terminology. The author's views as to what properly constitutes a generic name are clear, logical, and forcibly expressed. He rejects as *nomina nuda* the generic terms employed in Hübner's 'Tentamen,' Billberg's 'Enumeratio,' and other "equally worthless publications, which have been regarded as establishing priority for a name, although these names are unaccompanied by any description of the genus, and are only applied to one, or at most several species."

The bulk of the work, four hundred and sixty-three pages, is taken up in presenting a Synonymic Catalogue of the species, keys to the various families, subfamilies, and genera being provided. This portion of the work cannot fail to be exceedingly useful to the student, and may in general be said to be very well done. Here and there errors are discoverable, owing to the fact that the author did not have access to the types of some of the species which he enumerates. It is not, however, the purpose of the writer in the present brief review to point out these occasional blemishes, as attention would be more properly called to them in a journal specifically devoted to entomology.

The concluding portion of the text, pp. 493–537, is devoted to a discussion of facts relating to the distribution of species in the various zoögeographical subregions of the Ethiopian territory, and the relationship of the butterfly-fauna of Africa to the lepidoptera of other portions of the earth, followed by some observations upon seasonal dimorphism and protective mimicry. This is to the general student the most interesting part of the entire treatise, and brings into light some highly interesting facts.

The Ethiopian butterfly-fauna includes one hundred and twenty-eight genera, of which eighty-six, or nearly 68 per cent. are peculiar to this region. Of the forty-two genera, which occur in the other regions of the earth, eight, *Danais*, *Pyrameis*, *Libythea*, *Cupido*, *Heodes* (*Chrysophanus*, *Auctorem*), *Pieris*, *Colias*, and *Papilio* are more or less cosmopolitan, while *Acraea* (sens. lat.), *Catopsilia* (sens. lat.), and *Terias* are common to the tropics and sub-tropics of both hemispheres. Of the remaining thirty-one genera which the Ethiopian region possesses in common with other regions, twenty occur in the Indo-malayan, and to some extent also in the Austro-malayan Regions, but are altogether wanting in the Palæacrtic region. These genera are *Euplœa*, *Elymnias*, *Melanitis*, *Henotesia*, *Atella*, *Salamis*, *Hypolimnas*, *Kallima*, *Eurytela*, *Ergolis*, *Biblia*, *Cyrestis*, *Abisara*, *Deudorix*, *Hypolycæna*, *Spalgis*, *Lycænesthes*, *Leptosia*, *Appias*, and *Eronia*. The genera *Yphthima*, *Precis*, *Charaxes*, *Spindasis*, and *Teracolus* are Indo-malayan, although they are represented by one or other species in the extreme southern portion of the Palæarctic Region. *Argynnis* and *Neptis* are well represented in the Palæarctic and Indo-malayan Regions, *Pararge*, *Brenthis* and *Phyllocharis* are to be classed as Palæarctic genera, though they are represented in the northernmost portion of the Indo-malayan Region, and *Brenthis* is found in North America, and extends along the western Cordilleras to the extreme southern end of the continent of South America. The only remaining genus, *Hypanartia*, is peculiar to Africa and the tropical and subtropical regions of the Western Hemisphere.

Of the forty-two genera which Africa possesses in common with other regions, all except the three palæarctic genera and *Hypanartia* are found in the Indo-malayan region. Whether they migrated from Asia into Africa or from Africa into Asia cannot well be determined, but that, if such migration occurred, it must have been at a time when climatic and other conditions were widely different from what they now are, is plain. A wide barrier of sea and arid lands devoid of suitable vegetation separates at the present time the regions in which these insects, for the most part forest-loving, occur. The sandy wastes of Arabia and the rocky plateaus of Abyssinia are a great and impassable barrier, to say nothing of the Indian Ocean, to the transfer of genera which frequent the hot and dense forests of tropical West Africa and the equally hot and heavily timbered lowlands of India and the Malay archipelago. In Arabia, the present dividing region, many of these genera are altogether wanting.

Pararge and *Phyllocharis*, palæarctic genera, may have entered the region in which they now occur by migration along the Nile. It is quite different with the genus *Brenthis*, which occurs isolated upon the slopes of Kenia, Kilimanjaro, and Ruwenzori, the lofty volcanic peaks which dominate the plains of eastern and southeastern Africa. The nearest locality in which this genus finds representation at the present time is in the Alps of Switzerland, the Himalayas in India, and the Andean region of Patagonia. That the genus *Brenthis* should occur on the lofty summits of the East-African mountains and be there as the result of a migration from Switzerland, the Himalayas, or Patagonia, under conditions such as exist at the present time, is an untenable hypothesis, which no student would venture to advocate. The occurrence of *Hypanartia* only in Africa and South America, and the existence in Africa of the genus *Crenis*, so closely related to the South American genus *Eunica*, as scarcely to be separable from it, are facts pointing strongly to the existence in some remote time of a land connection between the continents of Africa and South America. Correlated with the facts as to the distribution of these genera of butterflies is the fact that in the avifauna of Africa and South America we find the *Struthionidæ*, or ostriches represented in both localities, and the species of the genus *Rhipsalis*, of the Opuntieæ occurring in the Cameroons and Madagascar, are witnesses in the floral world to the ancient bond between two now widely separated continents. To these facts cited by our author the writer may add the fact that in the elder groups of the arthropoda, as for example the Phrynidæ, similar instances of the occurrence of closely related forms in Africa and tropical America occur. These things all go to confirm the view which is coming to be generally held by geologists and paleontologists upon apparently strong and sufficient grounds, that in the mesozoic and elder tertiary, a union between the Eastern and Western Hemispheres existed by means of an Antarctic continent, which has largely disappeared, but which at that time, in some way united Africa and Madagascar, and very probably likewise Australia, to the land-mass now known as South America.

Under the head of 'Mimicry' the author gives a list of forty-nine species which are mimicked and sixty-six species which mimick them. It is very doubtful whether this list is correct in representing certain species as mimes, especially where a species of *Terias* is represented as mimicking a *Pieris*, or a *Catopsilia* the female of *Teracolus*. The cases cited, with which the present writer is very familiar, do not come under the head of 'protective mimicry' at all, but fall into the common category of general resemblance or family likenesses. This part of the work, while interesting, gives evidence of less care in preparation and less familiarity with essential facts than any other part of the work.

Upon the whole the student of African entomology has great reason to be grateful to Professor Aurivillius for having had the patience and zeal to prepare this monumental volume, which must for years to come serve as a key for unlocking the treasures of knowledge as to the butterfly-fauna of the Dark Continent.

W. J. HOLLAND.

WESTERN UNIVERSITY OF PENNSYLVANIA,
February 24, 1900.

Zoological Results based on Material from New Britain, New Guinea, Loyalty Islands and elsewhere, collected during the years 1895, 1896 and 1897, by Arthur Willey. Cambridge, Eng., the University Press. 4to. Part III., May, 1899; pp. 207–356; plates XXIV.–XXXIII.

Part III. of Dr. Willey's 'Zoological Results' opens with an account by Gadow of the variations in the number and arrangement of the scutes on the carapace of the loggerhead turtle. The material consisted in part of twenty specimens of new-born loggerheads all taken from one nest in New Britain and all showing abnormal numbers of scutes. This was supplemented by fifty-six other specimens from various collections, making in all a total of seventy-six individuals examined. The typical arrangement of the scutes on the loggerhead is as follows: The chief axis of the carapace is covered by six median elements; these are flanked by five pairs of costals; and the edges of the carapace are bounded by thirteen pairs of marginals. In studying the variation of these parts, Gadow has confined his attention to the median and costal elements. The variations in these series took the form of supernumerary scutes. Thus the total number of median elements may rise from six to seven or eight, and of costal elements on a given side from five, to six, seven, or even eight. In the costal scutes the variations were in some instances symmetrical, in others unsymmetrical. It will be observed that all these variations lie above the normal, and, as there is reason for believing that primitive turtles had a greater number of scutes than modern ones, Gadow holds that these variations are to be interpreted as atavistic. According to his belief, the ancestral turtles possessed at least eight median and eight pairs of costal plates. The reduction of these by which the condition in the loggerhead was reached, as indicated by the variations observed, was as follows: Of the original eight median scutes, the seventh was probably the first to disappear, followed by the fifth, thus giving rise to the series of six, typical for the loggerhead; of the original eight pairs of costals, the second pair was probably first lost, then the fifth and, by the fusion of the seventh and eighth, the condition of five pairs characteristic for this species was reached. For variations of this atavistic kind, Gadow, without further comment, proposes the term orthogenetic, a rather summary procedure in our opinion, since this term has already been extensively employed by Eimer for a different phenomenon. More or less looseness, however, pervades the whole paper and appears strikingly in the diagrammatic figures VII. and VIII. (p. 217), which, though intended to make the subject clear, really lead to confusion from the fact that the system of cross-hatching adopted is incorrectly used. It is to be regretted that a little more care was not exercised in the preparation of what is otherwise an interesting and valuable contribution.

The second paper in this part is by Dr. Willey himself and deals with the South Pacific and West Indian Enteropneusta. To the five species of these worm-like animals previously known from the region in which Dr. Willey collected, three new species are added. Two other new species from the West Indies are also described. The paper contains a synopsis of the families and genera of the Enteropneusta and a full description of the new species. These organisms are of importance because of their supposed relation to vertebrates, and the concluding part of Willey's paper deals with their morphology from this standpoint. A comparison of the central nervous organs, of the supporting axis of the body, of tubules kidney-like in character, and of the gills in the Enteropneusta, the tunicates, and the vertebrates confirm the belief in the natural affinities of these three groups of animals. In the course of this discussion the author suggests the novel idea that the genital glands and gill-slits were primarily unlimited in number and coextensive in distribution, and that the primary function of the gill-slits was the oxygenation of the genital glands, their secondary function being the respiration of the individual.

The concluding paper is by Shipley and deals with the five species of Echinoids collected by Willey. A revision of this group of worms is given together with an account of their geographical distribution.

G. H. Parker.

Minnesota Plant Life. By Conway MacMillan. Report of the Survey; Botanical Series, III. St. Paul, Minnesota, October 30, 1899. Octavo, 568 pages.

This is probably the most remarkable State report ever published. The author has given to the world a thoroughly scientific treatise, which is a contribution to our knowledge of the flora of Minnesota, and yet he has done so in such a way that, at the same time, the volume is one of the most popular of the State reports. This fact alone would mark the book as one of the most notable of recent publications, but when we add the beauty of its typography and illustrations, excellence of paper, and perfection of printing, so generally wanting in State Reports, we are doubly surprised. It is encouraging to find an author, who is an acknowledged master of the vocabulary of technical science, who here shows that he is equally at home in the non-technical presentation of strictly scientific facts in a somewhat new field of botany, and to learn that even State printing may be brought to compete successfully with the finest work done in private establishments. This volume is thus a distinct gain along more than one line.

The purpose of the book cannot be told better than in the author's own words: "In the pages of this book I hope to give the reader an idea of the diversified plant life which occupies the air, the soil and the waters of Minnesota. First of all, it must be remembered that plants, although passive creatures, are quite as truly living beings as are the more active animals. Just as men and women, either themselves or their ancestors, have entered the state from some other region, so also have plants, according to the nature of each, found their way and selected their abodes. It is no easy problem to determine why some family has chosen one village rather than another. This may have been from causes which are too subtle or too remote for analysis, but it is recognized that people have not come to make their homes without some reason which seemed sufficient to them or to their forefathers. So, too, there is always some reason for the appearance at a particular spot of one kind of plant rather than another, and it is possible, in a general way, to explain the vegetation of the hills and meadows of the state" (page 1).

Then follow simple discussions of the geography, climate and physical history of Minnesota, the laws of plant distribution, plant zones, the forests of Minnesota and the world, the North American flora, plant wanderings and migrations, associations between migrating plants, struggles of migrating plants, etc.

In speaking of the number of species of plants, the author estimates that of the 300,000 now living, about 7500 are probably to be found growing without cultivation in Minnesota, and distributes them approximately as follows: Slime moulds (which later he says are 'more probably animals') 150; bacteria and algæ, 1000; fungi and lichens, 3250; liverworts and mosses, 500; ferns and flowering plants, 2600.

Thirty-seven chapters are given to a general account of the vegetation of the State, under such heads as 'Slime Moulds and Blue-green Algae,' 'The lower sorts of Fungi,' 'Carrion-Fungi and Puff-balls,' 'Lichens and Beetle-fungi,' 'Mosses and Liverworts,' 'Ferns and Water-ferns,' 'Ground-hemlocks and various Pines,' 'Grasses and Sedges,' 'Poplars and Willows,' 'Roses, Peas and their Relatives,' 'Wintergreens to Chaffweeds,' 'Peppermints to Plantains,' 'Dandelions, Ragweeds and Thistles.'

The remaining chapters (XL. to XLV.) are devoted to a general discussion of the ecological problems involved in a full understanding of the flora. One of these takes up 'Adaptations of Plants to their Surroundings,' in which the several factors, Gravity, Mechanical Forces, Heat, Light, Moisture, Electricity and Magnetism, the Soil or Substratum, Other Living Things, and Intra-specific Adaptations are discussed. Another is given to Hydrophytic Plants, another to Xerophytic Plants, and still another to Halophytes and Mesophytes. These chapters, in spite of their titles, are very simply treated, and may be read easily by any person of average ability. The closing chapters are more philosophical and are devoted to the Maintenance of the Plant Individual, and the Maintenance of the Plant Species.

The author has certainly succeeded "in portraying the vegetation of Minnesota as an assemblage of living creatures, as a world of infinite variety, yet with a fundamental unity of plan, as forms linked together in structure, function and adaptation," and he has done so in language so simple, and yet so precise as to afford to us a new suggestion as to the presentation of scientific matter for the public. There is here left no opportunity for the shallow book-writer to take the author's results and work them over into more popular form, with the inevitable errors, inaccuracies and misrepresentations which characterize such productions. Professor MacMillan has wisely chosen to supply his own popular edition.

Charles E. Bessey.

The University of Nebraska.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for February has for its first article a paper by Henry Fairfield Osborn on 'The Angulation of the Limbs of Proboscidia, Dinocerata and other Quadrupeds in Adaptation to Weight.' Stephen R. Williams discusses 'The Specific Gravity of some Fresh Water Animals in Relation to their Habits, Development and Composition,' the conclusion being that the movements of an animal are closely related to its density and this in turn to its food habits. Carl H. Eigenmann and George Daniel Shafer describe 'The Mosaic of Single and Twin Cones in the Retina of Fishes,' Thomas H. Montgomery has a 'Note on the Genital Organs of Zaitha,' and Maynard M. Metcalf in 'Willey on the Enteropneusta' directs attention to some of that author's far-reaching theoretical conclusions. The 'Synopses of North American Invertebrates' are again continued, Mary J. Rathbun contributing the seventh part on the Cyclometopous or Cancroid Crabs. The balance of the number is occupied with reviews of recent literature.

In *The Osprey* for February, Paul Bartsch continues his 'Birds of the Road,' and under 'Esthetic Birds' is given Beccari's account of the Gardener Bird of New Guinea. Eugene S. Rolfe presents 'Nesting Notes on the Waders of the Devil's Lake Region,' and W. E. Clyde Todd has an excellent article on 'The Requirements of a Faunal List,' while Philo W. Smith, Jr., describes the 'Nesting of Stephen's Whip-poor-will.' The editor contributes some valuable comments on 'The Origin of the Hawaiian Fauna,' and there are some interesting letters and notes.

The *Journal of the Boston Society of the Medical Sciences* for January 16th, has for its leading article a paper by Theobald Smith on 'Variation among Pathogenic Bacteria,' a subject to which Dr. Smith has paid particular attention for many years. As he states, on the one hand the element of variability has been overlooked, and on the other hand the tendency to concede to bacteria any degree of variability, has given rise to theories which leave but little importance to pathogenic bacteria in the ætiology of disease. The writer concludes that since new disease germs are not constantly appearing the inference is that most species cannot adapt themselves to a parasitic existence. Mark W. Richardson has a note 'On the Cultivation of the Typhoid Bacillus from Rose Spots'; E. W. Taylor describes a case of 'Gumma of the Oblongata,' remarkable for the location and size of the tumor, and James H. Wright notes 'A Simple Method for Anaërobic Cultivation in Fluid Media.'

A Revue des revues d'histoire naturelle has been established at Paris under the direction of MM. Coupin and de Courdirban. It is published bi-monthly.

Dr. A. S. Eakle, assistant in mineralogy at the University Museum, has become the American editor for Groth's *Zeitschrift für Krystallographie.*

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF BIOLOGY.

At the meeting of February 12, 1900, presided over by Professor Bashford Dean, the following program was offered:

J. A. MacGregor, 'On the Development of the Skull in Ceratodus.'

F. B. Sumner, 'Kupfer's Vesicle in Relation to Gastrulation and Concrescence.'

G. S. Huntington, 'Some Muscle Variations of the Pectoral Girdle.'

J. H. MacGregor gave a brief preliminary report on the development of the skull in Ceratodus, the Australian lung-fish. The research was made conjointly with Professor Bashford Dean.

Only the early stages of the chondrocranium have as yet been studied; but it is noteworthy that these early stages show even closer resemblance to the amphibian skull than does the adult. The suspensorium is autostylic from the first, and the union of quadrate to cranium by ascending and otic processes is exactly as in urodele amphibia. The hyomandibular appears later than the body of the hyoid arch, and has no connection with the jaws. The trabeculæ are widely separated, leaving a large ventral fontanelle, also an amphibian character. The palatopterygoid bar is almost entirely suppressed. The one character which is entirely fishlike is the otic capsule.

A summary of Mr. Sumner's paper is as follows:

I. The generally accepted account of the gastrulation in the Teleosts as proposed first by Götte, was shown to be incomplete, in so far as it failed to give a true account of the hypoblast.

II. A view of Kupfer's vesicle was maintained, closely similar to that proposed by the great morphologist after whom the structure has been named.

III. The present author has arrived, on purely morphological grounds, at a view of concrescence identical with that proposed by Kopsch on the basis of the latest experimental work.

Dr. George S. Huntington's paper dealt specifically with the retro-clavicular group of supernumerary muscles, for the purpose of determining their mutual relationship and common derivation. The new muscle, here described for the first time, completes a series of retro-clavicular aberrant muscles which represent different stages in migration and recession of the typical mammalian M-sterno-chondro-scapularis. The members of this group appear therefore as myo-typical reversions representing persistent portions of this muscular plane, with secondary skeletal attachments depending upon the degree of recession.

FRANCIS E. LLOYD,
Secretary.

SECTION OF GEOLOGY AND MINERALOGY.

AT the meeting of February 19, 1900, with Mr. G. F. Kunz in the chair, there were sixteen persons present.

Professor R. E. Dodge announced the death of Dr. Hans Bruno Geinitz on December 30, 1899. He also stated that Professor J. J. Stevenson had been appointed by the Council of the Academy as delegate to the coming meeting of the International Geological Congress, and that the Council had voted to become a subscriber to the fund of that Congress.

The Chairman briefly discussed the character and work of Dr. Geinitz, and, on motion, Professor Stevenson was appointed a committee to prepare a minute on this great loss to the Academy and to science.

The following specimens were exhibited by the Chairman:

Corundum from Raglan Township, Ontario, Canada.

Variously colored sapphires from a new locality, Clear Creek, Granite county, Montana.

Corundum from a serpentine dike at a new locality, Corundum Hill, Plumas county, California.

The regular paper of the evening was then read by Dr. Henry S. Washington, illustrated by diagrams and specimens:

'The Igneous Complex of Magnet Cove, Arkansas.' The structure of the complex is described and, from the evidence of the form of the area, the relations to the surrounding shales, the presence of an overlying zone of metamorphosed rock, the arrangement of, and the serial petrographical and chemical characters of the main rock types, with other minor points, the conclusion is drawn that the igneous complex is probably a laccolith, and certainly a unit; and that the main component abyssal rocks are not due to successive injections, as was suggested by J. F. Williams, but are the result of a differentiation *in situ* of the mass of magna.

The main rock types are described, some new analyses being given, and they are shown to form a regularly graded series of interesting rocks, ranging from basic jacupirangite, through biotite-ijolite, typical ijolite, shonkinitic syenite and leucite-syenite, to foyaite. This serial, and common genetic character is shown both mineralogically and chemically. It is probable that the dikes of tinguaite and nepheline-porphyry are aschistic, while those of monchiquitic rocks are diaschistic.

The arrangement of the abyssal rocks is shown to differ radically from most other cases of differentiated laccolithic masses and dikes, in that there is progressive increase in acidity toward the periphery. One or two other instances of this are mentioned, the most closely analogous being the laccolith at Umptek in Kola (Finland).

An explanation of this is given, based on a process of fractional crystallization or freezing of the magma, and the idea applied to other cases. It is suggested that the laccoliths and similar magnetic masses, which have been studied, may be referred to three distinct types, the differences between which would be satisfactorily accounted for by the hypothesis.

In the ensuing discussion Dr. Washington pointed out that the specimens of the rocks represented by his analysis had not been selected in a radial line, but at various directions at increasing distances from the central mass of basic constitution.

Alexis A. Julien,
Secretary of Section.

TORREY BOTANICAL CLUB.

At the meeting of January 31, 1900, six new members were elected.

The scientific program consisted of a paper on the cultivation of palms, by Mr. Henry A. Siebrecht. After a general discussion of the palms as a botanical group, and of the various types represented in tropical regions, a full and interesting account was given of their cultivation in conservatories and as house plants, with valuable suggestions for their treatment and care in the household. The characters of various species suitable for cultivation indoors were given, especially of the genera *Cocos*, *Kentia*, *Phœnix*, *Areca*, *Caryota*, *Licula* and *Thrinax*, of which fine illustrations were shown from Mr. Siebrecht's nurseries. Among these were *Cocos Weddelliana*, *Phœnix Canariensis*, *P. Rupicola*, *Areca lutescens* and *Licuala grandis*. An accoant of Mr. Siebrecht's extensive nurseries in the tropical regions of Trinidad was afterwards added by request of some of the members.

Discussion followed by Mr. Henshaw, Mr. Lighthipe and Dr. Rusby.

L. M. Underwood,
Secretary pro. tem.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

The 513th meeting of the Society was held at the Cosmos Club on February 17th. Professor T. J. J. See, of the Naval Observatory, on behalf of the committee on Mathematical Science, presented a brief report on the progress of Theoretical Astronomy during 1899. Attention was drawn to the completion of *M. Poincaré's Méthodes nouvelle de la mécanique*, a work of the highest theoretical interest, and promising important practical extension in certain directions. It seemed probable that the methods depending on periodic solutions will be of much greater use in connection with the theories of stability and limits of variations, than in the practical construction of tables.

The progress of the Lunar Theory in the hands of Professor E. W. Brown was noted, and attention was drawn to the necessity for a practical test of the theory in the way of the construction of new tables for the Moon. The speaker thought the Nautical Almanac Office might take up the Lunar Theory in the near future as one of its principal lines of work.

The report noted the progress of Professor Eichelberger's researches on the tables of the Watson Asteroids, and Professor Stone's researches on the theory of the perturbation of Hyperion. Attention was also called to Professor Brown's researches on the satellite of Neptune, which enabled him to deduce the oblateness of the planet from its perturbative effect on the motion of the Satellite.

Professor See referred to his own researches on the Sun's heat, recently published by the Academy of Science of St. Louis, and said he had some investigations in progress which would give more accurate theories of the densities and moments of inertia of the planets. In conclusion it was pointed out that if no discovery of an especially striking character had been made during the past year, it was apparent that the progress was steady and continuous, and touched some of the most delicate problems of the heavens.

Mr. Henry Farquhar read a paper on the 'Formation of a table of *n*th powers by means of their successive differences.' A rule was given and demonstrated for calculating any power of the natural series of numbers from 0 upwards, by simple addition, combined with multiplication by factors in no case exceeding the index of the power. The first number in the series of first differences is always 1 ; the first in that of the second differences the difference between $2^n - 1$, and 1 or $2^n - 2$; while the third series is evidently headed by $3^n - 3 \cdot 2^n + 3$, the fourth by $4^n - 4 \cdot 3^n + 6 \cdot 2^n - 4$, and the q^{th} by

$$q^n - q(q-1)^n + \frac{q(q-1)}{2}(q-2)^n - \frac{q(q-1)(q-2)}{2 \cdot 3}(q-3)^n + \cdots$$

The derivation of these numbers for the nth power from similar numbers for the $n-1$th power is very simple, since

$$q^n - q(q-1)^n + \frac{q(q-1)}{2} q-2)^n - \cdots = q\Big[q^{n-1} - q(q-1)^{n-1} \cdot + \frac{q(q-1)}{2}(q-2)^{n-1} - \cdots + (q-1)^{n-1} - (q-1)(q-2)^{n-1} + \cdots\Big]$$

The table below shows the succession of leading differences for each power as far as the fifth ; figures in the column to the left denoting powers, and each number in the body of the table being the sum of that immediately above it and that immediately to the left of the latter, multiplied by the factor at the head of its column. The calculation of a table of fourth powers is also indicated to the right ; the numbers at the top being taken from the preceding table, and each of the rest being the sum of that immediately above it and that immediately to the right of the latter. The number 24, in the last column, is a constant additive to the column preceding. The successive fourth powers appear in the left-hand column of the calculation.

	1	2	3	4	5
1	1	.	.	.	.
2	1	2	.	.	.
3	1	6	6	.	.
4	1	14	36	24	.
5	1	30	150	240	120

.	.	1	14	36	24
1	1	15	50	60	.
2	16	65	110	84	.
3	81	175	194	108	
4	256	369	302		
5	625	671			
6	1296				

A paper by Mr. J. R. Eastman on the 'Treatment of Reflection Observations at Greenwich Observatory,' announced for the evening, was not read on account of the unavoidable absence of the author.

E. D. PRESTON,
Secretary.

GEOLOGICAL SOCIETY OF WASHINGTON.

THE 98th regular meeting was held at the Cosmos Club, February 28, 1900.

Under informal communications Mr. G. K. Gilbert called attention to the peculiar level character of the ledges of rock crossing the bed of the Potomac, just above Harpers Ferry, and also in the bed of the Columbia river, near the mouth of the Umatilla. It was suggested that subaërial disintegration is effective in reducing, to approximately the water level, those portions of the rocky bed which are not ordinarily covered with water.

On the regular program Mr. W J McGee presented a paper on 'The Gulf of California as an Evidence of Marine Erosion.' It was shown that the powerful tides of the Gulf, aided by frequent gales, are the cause of vigorous marine erosion where the tidal currents are constricted by the islands Tiburon, Esteban, and San Lorenzo. The erosion results in submarine terraces, up to a mile in width, covered with shallow water, and backed by precipitous coastal cliffs. At the outer edges of these terraces there is a rapid descent into deep water.

A discussion on 'The Conditions of Formation of Conglomerates, and Criteria for distinguishing between Lacustrine and Fluviatile Beds,' was introduced by a paper from Professor W. M. Davis, briefly summarizing the criteria available for discriminating the two classes of deposits, and suggesting that the term *continental* proposed by Penck, should be used in those cases where it is not possible to determine whether a given deposit is lacustrine or fluviatile.

Mr. G. K. Gilbert followed with a short analysis of the conditions governing the formation of conglomerates. The dominant agencies are littoral and fluviatile. Hence the presence of conglomerates, in the absence of contrary evidence, indicates stream or shore action. The formations of Lake Bonneville and the superficial deposits of the Great Plains were determined as lacustrine and fluviatile respectively, not from the internal evidence of the deposits, but on physiographic grounds.

Mr. S. F. Emmons, referring especially to the regions covered by the Fortieth Parallel

Survey, stated that a fluviatile origin for the tertiary beds of the west was not considered, because their lacustrine nature was indicated by physiographic evidence.

Mr. Whitman Cross cited Blanford's description, published in 1879, of the Gondwána beds in India, and pointed out that the conclusion, then announced, as to the probable origin of these and other beds in India had probably been overlooked by geologists quite generally. The same criteria applied to the tertiary and mesozoic beds of the Rocky Mountain region would lead to the conclusion that many of them were of fluviatile origin. Mr. Cross, however, questioned the value of the criteria employed by Blanford, Penck and Davis, and would give most weight at present to the extent and distribution of the formations in question, and their relation to continental areas.

Mr. Bailey Willis remarked that he had been in the habit of reasoning back from conglomerates in order to reconstruct former physiographic conditions. Thus the conglomerate of the Puget Sound Basin, covering perhaps 10,000 square miles, was formed by glacial streams in Pleistocene time. The Pliocene conglomerates of California are delta deposits and are associated with uplift. The Eocene conglomerate of Washington State was laid down at the foot of steep bluffs of granite. The Pottsville conglomerate, composed almost wholly of residual quartz and widely distributed, can have been derived only from a coastal plain where it had been concentrated by marine action, and thence distributed by marine or fluviatile currents.

Mr. G. F. Becker pointed out that a lake was often only an expanded river and suggested that a more useful distinction than that between lacustrine and fluviatile deposits, would be one between materials laid down in rapidly moving and in comparatively still water. Deposits laid down by streams have their particles imbricated in one dominant direction. Beach deposits are capriciously imbricated and their pebbles are asymmetric.

F. L. RANSOME,
DAVID WHITE,
Secretaries.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 319th meeting was held on Saturday evening, February 24th. W. A. Orton spoke of 'The Sap Flow of the Maple in Spring,' describing a series of experiments undertaken with a view of ascertaining the cause of the the phenomenon. The results showed that it was due to plant physics rather than plant physiology, and had a direct relation to temperature, the sap being expelled by the expansion, caused by warmth, of the gas contained in the wood cells. M. B. Waite described 'The Peach Orchards of Michigan,' stating that they were located on the eastern shore of Lake Michigan, this body of water having the effect of mitigating the temperature of the region. Most of the farms, the speaker stated, were comparatively small, running from fifty to eighty acres in size, but owing to the methods of cultivation they yielded a good profit. Various methods of cultivation were discussed and the speaker touched briefly upon the disease of the peach known as 'little peach.' Both papers were illustrated by lantern slides.

F. A. LUCAS.

DISCUSSION AND CORRESPONDENCE.

INFINITESIMALS.

TO THE EDITOR OF SCIENCE: Will you kindly accord me space for a few remarks about Infinity and Continuity which I seem called upon to make by several notes to Professor Royce's Supplementary Essay in his strong work 'The World and the Individual'? I must confess that I am hardly prepared to discuss the subject as I ought to be, since I have never had an opportunity sufficiently to examine the two small books by Dedekind, nor two memoirs by Cantor, that have appeared since those contained in the second volume of the *Acta Mathematica.* I cannot even refer to Schröder's Logic.

1. There has been some question whether Dedekind's definition of an infinite collection or that which results from negativing my definition of a finite collection is the best. It seems to me that two definitions of the same conception, not subject to any conditions, as a figure in space, for example, is subject to geometrical conditions, must be substantially the

same. I pointed out (*Am. Journ. Math.* IV. 86, but whether I first made the suggestion or not I do not know) that a finite collection differs from an infinite collection in nothing else than that the syllogism of transposed quality is applicable to it (and by the consequences of this logical property). For that reason, the character of being finite seemed to me a positive extra determination which an infinite collection does not possess. Dr. Dedekind defines an infinite collection as one of which every *echter Theil* is similar to the whole collection. It obviously would not do to say a *part*, simply, for every collection, even if it be infinite, is composed of individuals; and these individuals are parts of it, differing from the whole in being indivisible. Now I do not believe that it is possible to define an *echter Theil* without substantially coming to my definition. But, however that may be, Dedekind's definition is not of the kind of which I was in search. I sought to define a finite collection in logical terms. But a 'part,' in its mathematical, or collective, sense, is not a logical term, and itself requires definition.

2. Professor Royce remarks that my opinion that differentials may quite logically be considered as true infinitesimals, if we like, is shared by no mathematician '*outside of Italy*.' As a logician, I am more comforted by corroboration in the clear mental atmosphere of Italy than I could be by any seconding from a tobacco-clouded and bemused land (if any such there be) where no philosophical eccentricity misses its champion, but where sane logic has not found favor. Meantime, I beg leave briefly to submit certain reasons for my opinion.

In the first place, I proved in January, 1897, in an article in the *Monist* (VII. 215), that the multitude of possible collections of members of any given collection whatever is greater than the multitude of the latter collection itself. That demonstration is so simple, that, with your permission, I will here repeat it. If there be any collection as great as the multitude of possible collections of its members, let the members of one such collection be called the A's. Then, by Cantor's definition of the relation of multitude, there must be some possible relation, r, such that every possible collection of A's is r to some A, while no two possible collections of A's are r to the same A. But now I will define a certain possible collection of A's, which I will call the collection of B's, as follows: Whatever A there may be that is not included in any collection of A's that is r to it, shall be included in the collection of B's, and whatever A there may be that is included in a collection of A's that is r to it, shall not be included in the collection of B's. If there is any A to which no collection of A's stands in the relation r, I do not care whether it is included among the B's or not. Now I say the collection of B's is not in the relation r to any A. For every A is either an A to which no collection of A's stands in the relation r, or it is included in a collection of A's that is r to it, or it is excluded from every collection of A's that is r to it. Now the collection of B's, being a collection of A's, is not r to any A to which no collection of A's is r; and it is not r to any A that is included in a collection of A's that is r to it, since only one collection of A's is r to the same A, so that were that the case the A in question would be a B, contrary to the definition which makes the collection of B's exclude every A included in a collection that is r to it; and finally, the collection of B's is not r to any A not included in any collection of A's that is r to it, since by definition every such A is a B, so that, if the collection of B's were r to that A, that A would be included in a collection of A's that was r to it. It is thus absurd to say that the collection of B's is r to any A; and thus there is always a possible collection of A's not r to any A; in other words, the multitude of possible collections of A's is greater than the multitude of the A's themselves. That is, every multitude is less than a multitude; or, there is no maximum multitude.

In the second place I postulate that it is an admissible hypothesis that there may be a something, which we will call a *line*, having the following properties: 1st, points may be determined in a certain relation to it, which relation we will designate as that of 'lying on' that line; 2d, four different points being so determined, each of them is separated from one of the others by the remaining two; 3d, any three points, A, B, C, being taken on the line, any multitude whatever of points can be determined upon it so that every one of them is separated from A by B and C.

In the third place, the possible points so determinable on that line cannot be distinguished from one another by being put into one-to-one correspondence with any system of 'assignable quantities.' For such assignable quantities form a collection whose multitude is exceeded by that of another collection, namely, the collection of all possible collections of those 'assignable quantities.' But points are, by our postulate, determinable on the line in excess of that or of any other multitude. Now, those who say that two different points on a line must be at a finite distance from one another, virtually assert that the points are distinguishable by corresponding (in a one-to-one correspondence) to different individuals of a system of 'assignable quantities.' This system is a collection of individual quantities of very moderate multitude, being no more than the multitude of all possible collections of integral numbers. For by those 'assignable quantities' are meant those toward which the values of fractions can indefinitely approximate. According to my postulate, which involves no contradiction, a line may be so conceived that its points are not so distinguishable and consequently can be at infinitesimal distances.

Since, according to this conception, any multitude of points whatever are determinable on the line (not, of course, by us, but of their own nature), and since there is no maximum multitude, it follows that the points cannot be regarded as constituent parts of the line, existing on it by virtue of the line's existence. For if they were so, they would form a collection; and there would be a multitude greater than that of the points determinable on a line. We must, therefore, conceive that there are only so many points on the line as have been marked, or otherwise determined, upon it. Those do form a collection; but ever a greater collection remains determinable upon the line. *All* the determinable points cannot form a collection, since, by the postulate, if they did, the multitude of that collection would not be less than another multitude. The explanation of their not forming a collection is that all the determinable points are not individuals, distinct, each from all the rest. For individuals can only be distinct from one another in three ways: First, by acts of reaction, immediate or mediate, upon one another; second, by having *per se* different qualities; and third, by being in one-to-one correspondence to individuals that are distinct from one another in one of the first two ways. Now the points on a line not yet actually determined are mere potentialities, and, as such, cannot react upon one another actually; and, *per se*, they are all exactly alike; and they cannot be in one-to-one correspondence to any collection, since the multitude of that collection would require to be a maximum multitude. Consequently, all the possible points are not distinct from one another; although any possible multitude of points, once determined, become so distinct by the act of determination. It may be asked, "If the totality of the points determinable on a line does not constitute a collection, what shall we call it?" The answer is plain: the possibility of determining more than any given multitude of points, or, in other words, the fact that there is room for any multitude at every part of the line, makes it *continuous*. Every point actually marked upon it breaks its continuity, in one sense.

Not only is this view admissible without any violation of logic, but I find—though I cannot ask the space to explain this here—that it forms a basis for the differential calculus preferable, perhaps, at any rate, quite as clear, as the doctrine of limits. But this is not all. The subject of topical geometry has remained in a backward state because, as I apprehend, nobody has found a way of reasoning about it with demonstrative rigor. But the above conception of a line leads to a definition of continuity very similar to that of Kant. Although Kant confuses continuity with infinite divisibility, yet it is noticeable that he always defines a continuum as that of which every part (not every *echter Theil*) has itself parts. This is a very different thing from infinite divisibility, since it implies that the continuum is not composed of points, as, for example, the system of rational fractions, though infinitely divisible, is composed of the individual fractions. If we define a continuum as that every part of which can be divided into any multitude of parts whatsoever —or if we replace this by an equivalent definition in purely logical terms—we find it lends itself at once to mathematical demonstrations, and enables us to work with ease in topical geometry.

3. Professor Royce wants to know how I could, in a passage which he cites, attribute to Cantor the above opinion about infinitesimals. My intention in that passage was simply to acknowledge myself, in a general way, to be no more than a follower of Cantor in regard to infinity, not to make him responsible for any particular opinion of my own. However, Cantor proposed, if I remember rightly, so far to modify the kinetical theory of gases as to make the multitude of ordinary atoms equal to that of the integral numbers, and that of the atoms of ether equal to the multitude of possible collections of such numbers. Now, since it is essential to that theory that encounters shall take place, and that promiscuously, it would seem to follow that each atom has, in the random distribution, certain next neighbors, so that if there are an infinite multitude in a finite space, the infinitesimals must be actual real distances, and not the mere mathematical conceptions, like $\sqrt{-1}$, which is all that I contend for.

C. S. PEIRCE.

MILFORD, PA., Feb. 18, 1900.

CURRENT NOTES ON PHYSIOGRAPHY.

DEFLECTION OF RIVERS BY SAND-REEFS.

AN article on 'The effect of sea barriers upon ultimate drainage' by J. F. Newsom (*Journ. Geol.*, vii, 445–451), describes several examples of rivers whose discharge is deflected to the right or left by the formation of an offshore sand-reef in front of their mouths, and suggests that such deflection may explain the course of rivers that now flow parallel to preexistent coast lines; for example, the Delaware below Bordentown, N. J.

This suggestion is evidently valid as a possibility, but it is not accompanied by tests that sufficiently distinguish deflections thus caused from deflections that arise from the spontaneous adjustment of streams to the weak strata that underlie the cuesta-makers of coastal plains having longitudinal relief. The lower Delaware cannot be a normal example of the latter class, because as the master river of its region it is the very one that should not be deflected by adjustment; on the other hand, it may truly fall under the former class because its deflection is in the sense of the dominant sand-drift along our Atlantic Coast. Examples of sand-reef deflections ought to follow the strike of strong or weak rocks, indifferently; while normal deflections by adjustment can only follow belts of weak rocks.

DEVELOPMENT OF THE SEVERN.

THE systematic development of rivers seldom finds better illustration than in the interaction of the 'waxing Severn and the waning Thames,' concerning which a number of new details and suggestions are given by S. S. Buckman (*Nat. Science*, xiv, 1899, 273–289). The growth of the Severn by headward erosion along the weaker strata that underlie the firmer oölites of the Cotteswold hills is advocated on good evidence, and a restoration of the original consequent headwaters that have now been diverted from the Thames system is attempted. The growth of obsequent branches of the subsequent Severn on the line of the beheaded consequent branches of the Thames is well presented as the reason for the peculiar unsymmetrical arrangement of the Severn tributaries in the neighborhood of Gloucester. The Frome, a branch of the Severn, is shown to have captured several of the westernmost headwaters of the Thames in the Cotteswold hills between Chalford and Edgeworth. The progressive diminution of the Coln, a branch of the Thames, by the successive diversion to the Severn of the two large branches that once came from Wales is offered in explanation of the very curious features of the present Coln valley in the upland east of Cheltenham: a valley of large-curve meanders is taken as the work of the original river; a narrower valley of small meanders, cut in the floor of the larger valley, is the work of the river after one of its upper branches was captured by the Severn; the wriggling course of the present stream on the floor of these smaller meanders is due to the further loss of volume after the second upper branch was captured.

Some further account of the Cotteswold streams and of their homologues in the Swabian Alp of southern Germany may be found in a paper by the undersigned on the 'Drainage of Cuestas' (Proc. Geol. Assoc., London, xvi, 1899, 75–93). The failure of even the obsequent streams fully to occupy their meandering valleys suggests that all the streams of the region have diminished in volume on account of climatic change or of deforesting and cultivation; beheading is therefore not alone the cause of the misfit of the Coln and its neighbors in the upper Thames system.

LANDQUART AND LANDWASSER.

Heim's explanation of the diversion of the upper waters that once belonged to the Landwasser by the headward growth of the Landquart in the Alps of eastern Switzerland has been made familiar in Lubbock's 'Scenery of Switzerland.' A serious difficulty that stands in the way of this explanation is presented by A. V. Jennings (*Geol. Mag.*, London, 1899, 259–270); namely, that the growth of the Landquart before its capture of the upper Landwasser would have had to be through a belt of resistant rocks, which usually rise high in ridges and peaks. If the capture really took place, it seems to have been long ago, for the divide at the head of the Landwasser appears to be formed not of bed rock as Heim implies, but of heavy morainic deposits by which certain streams, once captured by the Landquart, are now returned to the Landwasser.

Certain lines of evidence that might be found in connection with the form and attitude of the valley floors before the time of capture are not mentioned.

RIVER GORGES OPPOSITE LATERAL FANS.

A journey in Bokhara by Rickmers (*Geogr. Journ.*, xiv, 1899, 596–620) led to the headwaters of the Oxus, where a great body of conglomerates is deeply dissected, producing bad lands on a gigantic scale well illustrated by figures from photographs. The relation of the conglomerates to the lofty snow mountains further east suggests that the former represent an ancient 'wash' from the latter, the whole region now being uplifted and trenched. The local stream in a branch valley of the Yakh river excited the curiosity of the traveller by alternately passing through open basins and narrow rock-walled gorges, and as Rickmers was 'unable to find any mention of a similar phenomenon in the literature on the subject,' especial description of these 'Dandushka barriers' is given. They appear to be examples of gorges produced by a stream that has been displaced from the axis of its valley by the growth of large lateral fans such as may be seen in the upper Engadine of Switzerland. They are, therefore, analogous to gorges due to local displacement and superposition of streams on rocky beds by the irregular distribution of glacial drift, but they are of peculiar interest from their spontaneous production by the interaction of different members of a single drainage system. Although such features of a valley are as well specialized as the thorns and galls of a twig, they are not likely to be given any conveniently designative name by British geographers, inasmuch as one of the honorary secretaries of the Royal Geographical Society recently takes occasion to say that "the invention of a new scientific word is always a positive evil, to be avoided if possible" (*Geogr. Journ.*, 1899, 658). On the supposition that nothing worth naming remains to be discovered in scientific geography, this dictum may have value; but a hundred years hence geographers will probably look on the geographical terminology of to-day as we do on that of our predecessors a hundred years ago, when atoll and caldera, mesa and canyon, moraine, drumlin, esker and kame had no place in the English language.

AN AVALANCHE TRACK ON MT. SHASTA.

Among many items of interest in the introductory pages of Merriam's 'Biological Survey of Mount Shasta' (U. S. Dept. Agric., *N. Amer. Fauna*, No. 16, 1899), is the account of the path formed by a recent avalanche that must have been of unusual size, through a forest of large firs. After gaining headway in descending from the upper slopes, the snow cut a broad swath through the huge trees, carrying their trunks forward over a gently sloping tract, and strewing hundreds of great logs 75 to 100 feet long and 3 or 4 feet in diameter, in confusion over the broad area where the slide finally came to rest. Here a few trees that were left standing are deeply scarred 10 or 15 feet above the ground where they were struck by trunks that were carried forward over deep snow. A number of excellent heliotype views are given of the mountain, the frontispiece being particularly fine.

W. M. DAVIS.

ZOOLOGICAL NOTES.

REGENERATION AND LIABILITY TO INJURY.

IN a recent number of the *Anatomischer Anzeiger*, Professor T. H. Morgan gives an account of his later experiments on the regeneration of the appendages of the hermit-crab. It will be remembered that his first experiments, made at Woods Hole in 1898, showed that certain appendages, because of their protection within the mollusk shell in which the crab lives, regenerate after artificial amputation quite as readily as the more exposed appendages which in nature are constantly liable to injury, and which actually reveal a much higher percentage of injuries. This result was clearly at variance with the opinion of those who believe that there is a definite relation between the regenerative capacity of a part and its liability to injury.

Professor Weismann attempted to explain the phenomenon by attributing to the more or less protected appendages of the hermit-crab the inherited regenerative power of some remote ancestor—an ancestor which was not domiciled in a shell. Moreover, he thought the fact that the power of autotomy was possessed by the three anterior thoracic appendages—parts frequently subject to injury—and not possessed by the two protected posterior pairs, was evidence of the comparatively recent origin of autotomy, and the more remote origin of regeneration, Morgan having shown that the fourth and fifth pairs of legs do regenerate. In stating that "The adaptation for autotomy once gained, the power of regeneration had of necessity to become localized; that is to say, the apparatus necessary for it had to be transferred to those parts at which alone the breaking off of the the limb occurs," Professor Weismann gave, to use his form of expression, a new lead which Morgan has again followed in his series of experiments of the summer of 1899. These experiments show that the power of regeneration has *not* become localized, and that the first three thoracic legs can regenerate both when cut off proximal to, and when cut off distal to the breaking-point of autotomy. Moreover, the experiments of Morgan incidentally give additional reasons for his earlier conclusion that there is no relation between regeneration and liability to injury, for in removing the appendages, at a point proximal to the 'breaking-joint,' he laid bare a regenerative zone, which in a state of nature must almost never be called upon to exercise the function of repair.

Weismann's suggestion that in the last abdominal appendage the regenerated part would be renewed after the pattern of a tail-fin of the Macroura, rather than after the original pattern of a 'holdfast,' is shown not to be supported by the facts.

H. C. B.

COMFORT AND PRODUCTIVITY.

M. MAX GERARD, in the *Bulletin Scientifique*, of the University of Liege, January, 1900, shows the influence of the compensation of the workman upon the productivity of establishments, taking his data from Dechesne, Ansiaux, and Waxweiler. He places the values of services and products, as reported from the several countries, in certain cases, thus:

	Wages per diem.	Value of product: Labor per tonne.
United States	12.20 fr.	17.15 fr.
Great Britain	6.25 "	15.15 "
France	4.15 "	16.90 "
Belgium	3.20 "	10.50 "

It is thus found that the cost of the product is, as a rule, very slightly affected, in these different countries by the wages paid their workmen, and France, paying one third the wage given in the United States, finds the product to cost practically the same amount. Great Britain, paying one-half the wages paid in the United States, produces very little more cheaply. Belgium pays little more than one-fourth the wages ruling in similar establishments in America and the product costs two-thirds as much, and even this difference may be due, in some degree, to other conditions.

The author of the paper accounts for these facts by the interaction of wages and morale, largely, partly by the better nutrition of the well-paid man and his improved strength and spirits and ambition. He states that the engineers building the railway from Paris to Rouen made the experiment of furnishing the same nourishing and plentiful diet to their French laborer as was demanded by and habitually supplied to the Englishman working beside him, with the result that, after a short time, the product of the two men became the same. The four cases above were selected from among establishments doing substantially the same sort of work and marketing practically the same quality of product.

"On ne peut expliquer ces faits que par la productivité élevée de l'ouvrier américain qui possède plus d'activité, plus de vigilance, plus d'application au travail que ses concurrents. Il est effectivement placé dans des conditions supérieure au point de vue matériel, intellectuel et moral."

Rankine, in his 'Prime Movers,' makes substantially the same enunciation of a principle, recognized by every experienced manager of works, when, referring to the physical working effect of men and beasts, he states that the daily product depends upon the "health, strength, activity and disposition of the individual," and on the "abundance and quality of food and air, the climate, and other external conditions."

R. H. Thurston.

SCIENTIFIC NOTES AND NEWS.

Mr. Dean C. Worcester, assistant professor of zoology and curator of the Zoological Museum at the University of Michigan, has been appointed a member of the new Philippine Commission. Professor Bernhard Moses, of the chair of political economy of the University of California, has also been appointed a member of the Commission.

The Paris Academy of Sciences has elected as foreign correspondents, Dr. C. Zittel, professor of paleontology in the University of Munich, and Professor Wilhelm Pfeffer, professor of botany at the University at Leipzig.

Dr. A. Smith Woodward, of the Department of Geology of the British Museum, will visit the United States in the spring to study the cretaceous vertebrates in American museums.

Mr. J. B. Woodworth, instructor in geology at Harvard University, has been appointed assistant on the New York Geological Survey to study glacial features of New York. Mr. Woodworth will begin his studies in the lower Hudson Valley in the season of 1900.

Professor O. C. Farrington, of the Field Columbian Museum, has been appointed on the staff of the Commissioner General of the United States to the Paris Exposition, and will spend two months in Paris supervising the installation of the United States mineralogical exhibit.

Dr. Edward Ehlers, of Copenhagen, will go next month to Crete to make arrangements for the segregation of the lepers on the island. There are about 2000 of these and they will be placed on a small island off the north coast.

It is announced in *Nature* that Dr. C. L. Griesbach, the director of the Geological Survey of India, has gone for a tour in the famine districts of the Central Provinces, Bombay and Rajputana, with a view to examining into the practicability of sinking artesian wells.

The Faculty of Medicine, of Würzburg, has awarded its Rinecke Prize of 1000 Marks and a silver medal to Professor J. v. Kries, for his researches in physiology.

The adjudicators of the Hopkins prize, University of Cambridge, for the period of 1891–94, have awarded the prize to W. D. Niven, M.A., F.R.S., formerly Fellow of Trinity, for his memoir on 'Ellipsoidal Harmonics' (*Philosophical Transactions*, 1891) and other valuable contributions to applied mathematics.

We regret to record the death of Dr. Oliver Payson Hubbard, in New York City, on March 9th. He was born in Pomfret, Conn., in 1809 and graduated from Yale University in 1828. He acted as assistant to the elder Silliman whose daughter he married. He was appointed professor in Dartmouth College in 1836, having charge of chemistry and geology, and has since 1883 been emeritus professor. Dr. Hubbard was one of the founders of the American Association for the Advancement of Science.

Professor F. L. Harvey, who held the

chair of natural history in the University of Maine, committed suicide on March 6th. Mental depression resulting from overwork is assigned as the cause. He was born in 1850, graduated from the Iowa Agricultural College in 1868 and was appointed professor in the University of Maine in 1886. He was also botanist and entomologist to the Maine Experiment Station.

The death is announced of Senator Beltrami, professor of mathematical physics in the University of Rome and president of the Accademia dei Lincei.

Herr Daimler, the inventor of the motor car bearing his name, has died at the age of 66 years. His gasoline motor may be regarded as the starting point of the automobile.

Professor E. B. Fernow of Cornell University, lectured at Lehigh University on March 9th, his subject being 'The Evolution of the Forest.'

Mr. H. F. Newell, hydrographer of the United States Geological Survey, delivered an address before the Engineering Society of Harvard University, on March 7th, on the investigations being made by the division of hydrography.

A bronze medallion with a relief portrait of Pasteur has been placed on the house in Strassburg in which he lived in 1852.

Mr. Charles Whitehead, who has acted as technical adviser to the British Agricultural Department of the Privy Council, and subsequently to the Board of Agriculture, during the past fifteen years, has been compelled to resign that appointment owing to ill health.

Dr. Fridtjof Nansen expects to leave Christiania on May 15th in a specially constructed vessel to carry out hydrological investigations around Iceland for the Norwegian Government. The expedition will return in the autumn.

The case of Professor Neisser, of Breslau, accused of making vaccination experiments on human subjects, was again brought up in the Prussian Diet last week. It was reported for the Minister of Education, that the question had been taken up by the state attorney, but that prosecution was barred by the statute of limitation. Disciplinary proceedings were, however, in progress.

We have already noted that Mrs. Caroline Brewer Croft bequeathed $100,000 for researches into the cause and cure of cancer. This bequest was originally made to Drs. H. K. Oliver and J. C. Warren. They have turned over the bequest to Harvard University, and the medical school has organized the work to be prosecuted. Dr. E. H. Nichols, '86, goes to Europe to study cancer abroad.

In 1891 Mr. J. W. Charles de Soysa offered a bacteriological institute for Ceylon, but his gift was at the time declined. The offer was, however, repeated in 1897 and then accepted. The Institute, which is very well equipped, was opened by the Governor on January 31st. Dr. Marcus Fernando has been appointed the first director.

The Brooklyn Institute of Arts and Sciences has been granted an appropriation of $300,000 for the erection of a new wing for the Museum.

The estimates for the British Museum have been reduced £1000 for the coming financial year, but the trustees have petitioned Parliament to reconsider this decision.

A collection of Irish antiquities, formed during the last seventy years by Mr. T. R. Murray, of Edenderry, has been acquired for Cambridge University by Professor Ridgeway.

The Ithaca *Daily News*, for March, 6th devotes a number of columns to the publication of letters from leading naturalists and educators, advocating the establishment by the New York Legislature of a State Biological Station.

Mr. R. Horton-Smith, Q.C., M.A., of St. John's College, Cambridge, has offered to the University a fund of about £600 for the establishment of a prize for medicine and pathology, in memory of his son Raymond Horton-Smith, M.B., who, after a distinguished career in the university and at St. Thomas' Hospital, died in October, 1899, in his 27th year. The prize is to be awarded annually for the best thesis for the M. D. degree offered by candidates who have taken honors in one of the Triposes. The prize thesis is to be printed, and copies are to be sent to various officers and libraries of the university and the Royal College of Physicians.

The late Professor D. E. Hughes bequeathed £400 to the Paris Academy of Sciences for the establishment of a prize for the most important discovery in physical science, preference being given to a discovery in electricity or magnetism.

Under the direction of Professor A. A. Wright of Oberlin College, systematic excavation has been commenced in Brownhelm, Ohio, near Lake Erie and about twelve miles from Oberlin, to recover mastodon remains, the first of which were discovered several years ago. The jaws and head, both tusks, together with a number of ribs and vertebræ have been obtained in a good state of preservation. The bones are much scattered and lie upon a clay hardpan at the bottom of a muck bed four feet deep.

The Royal Meteorological Society, London, will celebrate its 50th anniversary on April 3d. The Council has arranged for a commemoration meeting to be held at 3 p. m. at the Institution of Civil Engineers, at which the president will deliver an address, and delegates from other societies will be received. In the evening a *conversazione* will be held at the Royal Institute of Painters in Water Colors. On the following day, April 4th, the Fellows will visit the Royal Observatory, Greenwich, and in the evening will dine together at the Westminster Palace Hotel. In view of this jubilee celebration, Mr. G. J. Symons, F.R.S., was elected president at the annual meeting of the Society on January 17th, but owing to illness he has since been obliged to resign this office. Under these circumstances the Council at their last meeting appointed Dr. C. Theodore Williams as the president of the Society.

The Committee of the Liverpool School of Tropical Diseases has decided to send out next month, under the direction of Dr. Annett, another expedition to West Africa. The expedition will make its headquarters in Old Calabar and carry on researches in southern Nigeria. If time and opportunity permit the upper Niger will be visited.

At a meeting of the British Astronomical Association on February 28th, Mr. Maunder announced that sufficient names had not been handed in to justify chartering a steamship to visit the Mediterranean at the time of the solar eclipse in May. A large number of names had been withdrawn owing to the war.

The United States Civil Service Commission announces that in view of the needs of the service all persons who have been examined within the past six months and have failed to attain eligible averages in the following named examinations will be permitted re-examination this spring upon filing new applications. These examinations will be held at various places throughout the country, beginning April 17, 1800: Acting Assistant Surgeon Marine Hospital Service, Aid Coast and Geodetic Survey, Assistant Department of Agriculture, Assistant Examiner Patent Office, Assistant Topographer, Civil and Electrical Engineer, Copyist Ship Draftsman, Farmer, Fish Culturist, Hospital Steward, Industrial Teacher, Meat Inspector, Kindergarden Teacher, Manual Training Teacher, Matron, Mechanical and Electrical Engineer, Physician, Register and Receivers Clerk, Seamstress, Superintendent of Construction, Surveyor General's Clerk General Land Office Service, Teacher, Topographic Draftsman, Trained Nurse.

An International Congress of Medical 'Electrology and Radiology' will be held at Paris from the 22d of July to the first of August. Professor Weiss of the University of Paris, is president and the general secretary is Professor Doner, University of Lille.

The Italian Government has decided to establish a bacteriological laboratory for the study of bubonic plague in the island of Pianosa.

We learn from the *British Medical Journal* that M. Fleury-Ravarin, Member of the Chamber of Deputies for the Rhône Department, has brought in a bill providing for the creation of a national antituberculous institute. The proposed institute is to be devoted to the study of the treatment of tuberculosis and experimental researches on the means to be employed for that purpose. The Société Lyonnaise des Tuberculeux Indigents has undertaken to build the institute at its own cost, and proposes to make it an annex of the free sanatorium which it is about to open at Hauteville, in the mountains of the Bugey district. M. Fleury-Ravarin asks the State to associate itself with this philanthropic work by conferring on the institute the title of 'National,' and granting it an annual subvention of £600.

A MEETING of the Organizing Council of the British Congress of Tuberculosis was held at house of the Royal Medical and Chirurgical Society on February 22d.

THE plague has appeared in Sydney, New South Wales, and on the Island of Cozumel, off the coast of Yucatan. A case has occurred in San Francisco. Deaths are still reported from Honolulu. There is no abatement in India, the deaths at Calcutta being 411 for the last week of which news is at hand.

RECENT issues of the *British Medical Journal* and *Nature* recommend the appointment of Professor William Osler, of Johns Hopkins University, to the chair of the practice of physic, vacant by the death of Sir Thomas Grainger Stewart. *Nature* says:

The desire has been widely expressed in University circles in Edinburgh that the Curators of Patronage, with whom the appointment to the chair of medicine rests, should offer the post to Professor Osler, of the Johns Hopkins University, who is well known as a teacher and clinicist of the highest scientific eminence, and whose acceptance of it would greatly strengthen both the systematic and clinical teaching in the University. It would appear, however, that the Curators have no choice in the matter, but are bound to advertise every vacancy, so that the far more satisfactory and dignified method of appointment by invitation is necessarily excluded. Nevertheless, it is confidently hoped that Professor Osler may be induced to send in a formal application for the chair, since it is certain that his claims would receive every consideration from the present Board of Curators, who have more than once, on recent occasions, shown that they are superior to merely local considerations, and that they have regard in making these appointments solely to the best interests of the University. Professor Osler is a Canadian by birth, and although he has for many years successively occupied the important chairs of medicine in Philadelphia and Baltimore, he has, we believe, never renounced his British nationality. His appointment to Edinburgh, although it would be felt as a serious loss by our kinsfolk on the other side of the Atlantic, would doubtless be considered by them, and especially by our Canadian fellow-subjects, as a graceful recognition that we are one people bound together in science, as in politics, by common interests, and that we are prepared to welcome the best man from whichever side of the water he may hail. Applications for the post, with testimonials, must be lodged with Mr. R. Herbert Johnston, Secretary to the Curators, at 66 Frederick Street, Edinburgh, on or before April 14th."

IN his annual report President Eliot writes of the observatory: "The director reports that the Harvard Observatory, which in 1892 had the second largest income among the great observatories of the world, in 1898, had only the fifth largest, the observatories at Washington, Paris, Greenwich and Pulkowa surpassing it in income and expenditure. This fall is occasioned by the decline in the rate of interest on the funds of the observatory. The observatory is now so well organized and so active and efficient that it will be a great pity if its resources, and, therefore, its powers of usefulness, are permitted to decline. It is the only observatory which maintains a station in the northern hemisphere and in the southern; and its collection of photographs of the entire sky gives it unique means of studying the recent history of the stellar universe. The photographic plates are now kept in a fireproof building; but the library of the observatory, which has become very valuable, is in a wooden building and is, therefore, exposed to complete destruction by fire. A fireproof building, which need not cost more than $15,000 or $20,000, ought to be provided for the safe keeping of this collection." Four volumes of the *Annals* have been in process of publication during the larger part of the year, and more than 30 volumes of the *Annals* have been published during the last 20 years—a rate of publication that is truly astonishing. "On November 28, 1898, Mrs. Williamina Paton Fleming was appointed Curator of Astronomical Photographs, and in that capacity her name appeared in the university catalogue for 1898–99. It is believed that Mrs. Fleming is the first woman who has held an official position in Harvard University. She is well known to astronomers as the discoverer of a remarkable number of new variable stars."

MR. SIMON W. HANAUER, Vice-Consul of the United States at Frankfurt, writes to the Department of State that nothing has been said of the San José scale for months in German papers. It has not yet made its début in a live condition in Germany, thus confirming the opinion of experts that the climatic conditions of Germany are not suited to its perpetuation; but, while the false alarm concerning the introduction and ravages of the San José scale has vanished, its ill effects in the nature of administrative measures against the import of American fruit have continued, and the hardship of these proscriptive ordinances are making themselves so acutely felt that German trade circles and consumers are beginning to protest. The chamber of commerce of the city of Hamburg (one of the most important trade bodies of Germany), in its lately published annual report, says on this subject: "The station which last year was opened in this city for the purpose of investigating the presence of the San José scale on American fruit has a laboratory where two scientifically trained experts, with fourteen assistants, have steadily pursued these investigations in the most circumspect manner. While there may not be any objection to examining 'raw fruit,' the continuation of investigations in regard to 'dried fruits' must be considered an utterly unnecessary hindrance to trade. The sanitary experts, whom the imperial German department of health, as well as the Belgian Government, sent last year to California, have fully confirmed the statements made by German fruit importers that the drying methods in use in the United States effectually kill the insects. Therefore, the scales found on dried fruit from America were dead. The trade suffers great damage from the examination, stricter here than elsewhere, and this chamber of commerce regrets that this unnecessary annoyance and harmful practice was not at once discontinued when the facts became known."

UNIVERSITY AND EDUCATIONAL NEWS.

New York University has received a gift of $100,000—it is reported from Miss Helen Gould—for the erection of a 'Hall of Fame for Great Americans.' Colonades overlooking the Harlem river will be erected containing 150 panels on which will be engraved inscriptions commemorating eminent Americans.

Columbia University has received from Mrs. Robert Goelet the gift of a bronze statue to cost about $25,000. It will represent 'Alma Mater' and will be erected in the court before the library.

Oberlin College has received a gift of $50,000 from Dr. and Mrs. Lucien C. Warner, of New York, for a men's gymnasium.

A bequest of £20,000 has been made to the New College, Hampstead (now a constituent college of London University), under the will of the late Mr. Henry Vaughan.

A daughter of the late Professor Hughes Bennet, of the University of Edinburgh, has offered the University a sum of money to establish an addition to the physiological laboratory for the purposes of research.

The Chicago College of Physicians and Surgeons was three years ago affiliated with the University of Illinois. An agreement has now been made effecting a more complete consolidation which is to last 25 years, and allowing the University of Illinois to secure complete control of the College.

Dr. Harris Hancock, A.B. (Virginia and Johns Hopkins) and Ph.D. (Berlin), has been elected professor of mathematics at the University of Cincinnati to fill one of the chairs recently declared vacant by the Board of Directors. Dr. Hancock has published papers on the Abelian functions, on the calculus of variation and other subjects. He is at present at Paris.

At Oberlin College, Simon F. MacLennan has been appointed professor of psychology and pedagogy, and Frederick O. Grover, professor of botany.

Professor R. S. Lawrence, of Emporia College, Kans., has accepted the chair of mathematics in Hanover (Ind.) College.

Professor Julius Hann, of Gratz, has been called to the professorship of cosmical physics, at Vienna. Dr. August Gutzmer has been made full professor of mathematics in the University of Jena. Dr. v. Schmidt, of Dorpat, has qualified as docent in histology and embryology in the University at Jena.

Dr. Th. M. Fries, professor of botany in the University of Upsala, has retired.

SCIENCE

FRIDAY, MARCH 23, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THIRD ANNUAL PURE FOOD AND DRUG CONGRESS.

IN harmony with a call issued by the Executive Committee, the third annual Pure Food and Drug Congress of the United States, assembled in Washington, D. C., on March 7th.

Delegates to this Congress were appointed by the Governors of the several States; by the State boards of agriculture and health; by the agricultural colleges and experiment stations; by the national trade organizations, both by wholesalers and retailers; by the National Grange; by the State Granges and by various other organized bodies. Over five hundred delegates were appointed and about three hundred attended the meeting, thirty-five States and Territories being represented by delegates in actual attendance. The meeting was a thoroughly representative one in every particular.

The principal object of this Congress was to promote national legislation relating to the inter-state traffic in adulterated foods, to provide inspection of food products shipped abroad and to regulate the sale of food products in the Territories of the United States and the District of Columbia. Under the constitution the power of the Congress cannot go farther than this.

For many years agitation in regard to this legislation has been going on, and the fundamental principles of the measure agreed upon have been endorsed by the various interests represented in this and the previous Congresses. The necessity for such legislation is apparent to every one. State laws are effective only when supplemented by national legislation. As long as adulterated foods are permitted to enter one State from another it is not possible for the State authorities to reach the real offender. The State courts can only punish the citizens of their own State, whereas the real culprit may reside across the State border in another jurisdiction. One of the best provisions of this measure, which has been endorsed by this Pure Food Congress, is that the original manufacturer or producer of the goods can be punished, while the innocent retailer or dealer may escape, by tracing the articles to their original source, and thus furnish evidence to convict the primary offender.

Another excellent provision of the proposed law, as endorsed by the Congress, is the inspection of food products intended for export to foreign countries. It is well known that many of our food products have been unjustly condemned in foreign countries, on alleged sanitary grounds or on alleged imperfections. Inasmuch as these food products have received no inspection before leaving the country it is quite difficult for our citizens to establish the character and purity of their exported food products. With rigid inspection by Government officials, before export, it would be a comparatively easy matter to maintain the rights of our food products in foreign countries. By reason of the increased scope and magnitude of the work of the Division of Chemistry and in harmony with the recommendations contained in the last annual report of the Secretary of Agriculture, to the President of the United States, the proposed legislation endorsed by the Pure Food Congress raises the Division of Chemistry to the dignity of a bureau.

Another excellent feature of the proposed measure is the absence of annoying, restrictive or prohibitive clauses. The pure food bill, as recommended by the Congress, does not inflict upon any honest dealer any rules or regulations, which will interfere in any way with his trade or make it difficult for him to conduct his business.

If the question of wholesomeness arises a provision is made for its study in a thoroughly impartial and effective manner. The bill provides for a board to be appointed by the President of the United States and the Secretary of Agriculture conjointly, consisting of five physicians, three of whom are to represent the Army, Navy and Marine Hospital Service, to be appointed by the President; a board of five experts, who are eminent in physiological chemistry and hygiene, to be appointed by the Secretary of Agriculture; and these together with the Chairman of the Committee on Pure Food Standards of the Association of Official Agricultural Chemists and the Chief Chemist of the Department of Agriculture of the United States, will form a board of twelve persons to whom all matters relating to wholesomeness of food products, or of materials added thereto, will be referred. It is evident that such an unbiased body will be able to reach conclusions, after proper investigations, which will merit the confidence of the country.

The administration of the law is confided to the Secretary of Agriculture, who is authorized to make all needful rules and regulations for carrying out the provisions of the act, and in doing this is to make use of the chemists and appliances of the Division of Chemistry of the Department of Agriculture. This method of administration has been approved of at all of the sessions of the Food Congress as being the wisest, most efficient and the most economical method of securing the purposes in view. The Secretary, at his discretion, can make use of the chemists and appliances of the various States engaged in food inspection, in order to render the service local, where the infringement of the law may have taken place.

The only element of discord in the Food Congress was developed by a proposal to establish an entirely independent food bureau, with an independent chemical laboratory, for the administration of the law. The head of this bureau, it was proposed, should be appointed by the President, for a term of four years, thus making the administration of the pure food law subject to frequent political changes. This provision was debated at great length for two days and at times with a degree of acrimony which indicated that some of the promoters of pure food legislation were more anxious to secure a new office than to establish a food law. At the end of this discussion the original plan, endorsed by previous Congresses, passed by a large majority and the bill thus approved was adopted without a dissenting vote.

On the third day of the Congress, by the invitation of the Committee on Interstate Commerce of the House of Representatives, a large number of the delegates attended the meeting of the Committee, at which the merits of the bill were presented in five minute speeches, by the representatives of the various industries attending the Congress.

In the interests of the public health and public honesty, it is to be hoped that the measure which has been recommended for the third time by this national Pure Food Congress, and which has the approbation of all the great trade interests of the country, will be pushed to a speedy vote and become a law before the present session of Congress adjourns.

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*THE ACCURACY OF THE EXPERIMENTAL METHODS OF THE CHEMIST.**

On occasions like the present, where intellectual labor is the chief aim of those who are assembled together, it is a frequent practice for the speaker to offer to his audience something of the fruit which he has gathered from his own investigations. To the thought which lies at the foundation of this custom, are due those inaugural addresses which can lay just claim to being contributions to scientific knowledge. Other speakers prefer to furnish to these cultured circles a glimpse into the workings and tendencies of the higher institutions of learning. It were to me a great pleasure, esteemed colleagues and fellow students, could my efforts to-day draw me closer to you ; at all events this address shall serve as a greeting of welcome from the Rector, now entering upon his office, to all those who are connected with this *Hochschule*, and to all those who feel in it a kindly interest. And it is in this last sense that I beg leave to offer a few thoughts upon

THE ACCURACY OF THE EXPERIMENTAL METHODS OF THE CHEMIST.

It is the well recognized task of scientific investigation to discover the truth, and in those cases where this is not possible, to approximate it as closely as possible. In the natural sciences we may look upon this goal as attained when it is possible, in the broadest sense of the word *to describe* that which is appreciable to the senses. For this purpose it is generally insufficient merely to allow the object to act directly upon the senses, without in any way modifying its natural conditions ; we must avail ourselves of external assistance which either shall like a lens render our observations more accurate, or shall make possible the study of the object under changed outward conditions. On the one hand we use meter stick, balance, microscope ; on the other Bunsen burner, electrolytic cell, Röntgen apparatus, and the like. One need but cast a glance into the workshop of our investigator to see what an arsenal of appa-

* Inaugural address of the Rector of the Technischer Hochschule, Graz, Hungary. Translated by J. L. H.

ratus of both these classes stands at the command of the modern investigator in natural science ; literally numberless are the conditions under which matter is ever anew compelled to yield up its secrets.

Let us now look more closely at the work of the chemist, that we may learn how far the results attained by the methods at his disposal may lay claim to exactitude.

The task which we have proposed may be treated in different ways. We could from a general standpoint, discuss the criteria by which the accuracy of an experimental method is to be judged. A method will thus be valued as exact according to the concordance of the results attained by it on many repetitions or according to the concordance of these results with those attained by other methods. The fulfilment of this last condition is especially of value, and we shall therefore later recur to an especially interesting case of this kind. The value of a method moreover will be further increased if it is fitted to broaden the field of experimentation ; just as a piece of apparatus is of increased value, when it is adaptable for different experiments.

I prefer, however, to pass by these more general considerations and to discuss the exactitude of experimental methods in their bearing upon a few problems, whose fundamental importance is recognized. Of these I select three.

First we will consider the proof of the law of *indestructibility of matter*, as an example of the degree of exactness for which experimental data can be obtained, where the *determination of atomic masses* is concerned.

A second problem will be the *delicacy of chemical reactions*, under which it is to be considered, how far the accuracy of our apparatus allows us to detect the existence of definite chemical substances. And if both of these cases shall lead us to increased confidence in our methods, and we come to feel that the exactness of our experimental methods is very great, our third study on the other hand will serve to shatter this confidence. This study is that of *the absolutely pure substance*, and brings us at once to the point where the experimenter is wholly convinced of the justice of the conclusion that the hands of man can never bring into existence the unconditionally perfect.

Before we enter upon a consideration of these three examples, however, it will be well to notice the case which has already been spoken of, which reveals, as hardly any other could, the fact that those views, which have been attained by very different ways, and which we form from facts and phenomena upon the basis of sentient perception, may coincide to a remarkable degree ; this is particularly the case if we take into account the possibility that our observations may not correspond to the reality quite as closely as the investigator commonly claims. In determining the density of the vapor of mercury, if one proceeds on the supposition that all gaseous bodies under the same conditions of temperature and pressure contain the same number of molecules in the same space, he comes to the conclusion that the vapor of mercury contains in the molecule only one-half as many atoms as that of hydrogen. If, as appears from the volume relation in the analysis and synthesis of hydrochloric acid, this hydrogen molecule contains two atoms, it then follows that in the vapor of mercury the smallest particles which exist in a free state are single atoms. Now it is possible to reach this result by a wholly different method. It is a familiar fact that the velocity of sound may be used to determine the relation between specific heats of gases at constant volume and constant pressure. For this determination the knowledge of volume and weight is necessary, and besides this a measure of length, that is the length of the sound waves. The experiment furnishes us for this relation in the case of the vapor of mercury a higher value than in most gases. This ratio is one and two-thirds, that is, it is exactly the figure which is demanded by the kinetic theory of gases for a gas which contains a monatomic molecule, where the atomic energy of the molecule can be neglected when compared with that of the molecule as a whole. The velocity of sound in the lately discovered gases, argon, helium, neon, xenon and krypton, has also been found to correspond to monatomic molecules. This knowledge stands further in beautiful harmony with the chemical properties of these elements, whose atoms—apparently *without affinity*—appear unable to enter into any kind of combination. They seemed doomed to eternal solitude.

We now come to the first of the three problems which we have proposed for our consideration to-day. The question of the indestructibility of matter can best be introduced by recalling the investigations of the distinguished Belgian chemist, Stas, who attained an exactness in his work which has excited the admiration of all succeeding chemists. His investigations especially reveal where the experimental possibilities in this field find their limit. A closer view of his work would unfortunately compel us to enter upon a series of dry studies of figures. We will, however, take one example from among these. In order to prove our law, Stas prepared synthetically three quarters of a kilo of silver iodid, a quantity which the analytical chemist would consider enormous, and he found this weighed only fourteen and one-half milligrams less than the weight of the constituents of the compound. This is an accuracy reaching one fifty-thousandth part of the whole quantity. How extraordinarily close to complete agreement these figures lie may be judged when one considers that in our ordinary gravimetric methods, using perhaps a gram of substance, an error of one milligram may certainly be looked upon as small. This is an error of a one-thousandth of the whole quantity used.

As further experimental contributions to the law we are considering the work of Kreichgauer and that of Landolt is interesting. These investigators have carried on chemical observations in fused glass tubes in order to decide, by most careful weighing, these two questions: whether in a reaction, a ponderable portion of ether disappears or is added to the substances used; and whether the products of a reaction are influenced in exactly the same way by gravity as are the factors which enter into the reaction. Kreichgauer's experiments were calculated to detect a change in weight which would have amounted to one twenty-millionth of the mass present, but even this minute change of weight was not detected. In Landolt's experiments it was also impossible to detect any change in weight, although he did not consider the possibility of such a change absolutely excluded, chiefly because the variations, which were considerably less than one-tenth of a milligram, were always in the same direction.

In more recent times Ramsay and Rayleigh have carried out extremely accurate experiments. These distinguished scientific observers at first set before themselves merely the problem of determining, with the greatest possible accuracy, the weight of a few gases, among others that of nitrogen; but in the course of these investigations they came to the most unexpected results, for they were led to the discovery, and later to the separation of the unknown constituents of the air, argon, xenon, etc., as already mentioned. In such ways, an ever increasing perfection leads to ever more accurate results. And if it be true that in all investigations of this kind we must be denied the possibility of reaching the absolute truth, there is, nevertheless, infinite satisfaction in the consciousness that we may approach nearer and nearer to the goal. The experiments of Ramsay and Rayleigh, however, lead us also to the knowledge that with the perfection of our methods, there may follow also the discovery of wholly new facts; and so investigation and experimentation are always worth while. They also bring as a reward answers even more numerous than the questions proposed. In other words, as in other fields, so also in natural science, one advance seldom takes place alone. In this sense it is not just that we should so frequently speak of notable discoveries being made by accident; for we thus minimize the labors and the deserts of the experimenter in the minds of others who are not familiar with his work.

We pass now to our second example. Methods which have for their aim the qualitative detection of elements are, other things being equal, considered more valuable according as they are more sensitive, that is according as they lead one to his desired end with the use of the least possible quantity of substance. In this respect it seems to be almost universally accepted that the smallest quantity of substance can be recognized, not by special experimental apparatus, but directly through one of our senses—that of smell. On the one hand this assumption rests upon the observation of E. Fischer and Penzoldt, that the limit of perception of the odor of mercaptan is reached when one four hundred and sixty-millionth part of a milligram of the substance is present. On the other hand the work of Kirchhoff and Bunsen shows that by spectrum analysis one fourteen millionth of a milligram of sodium can be recognized with certainty. By this it is not to be understood that Kirchhoff and Bunsen submitted this quantity as the smallest amount of a given element which will suffice to give a spectrum recognizable with certainty, but they merely put forth this statement to show the superiority of the methods of spectrum analysis in general. My own observations, the details of which do not belong here, have at all events convinced me that it is easy to so extend in spectrum analysis the limit of sensitiveness that we must to-day look upon spectrum analysis as by far the most delicate of all analytical methods. It is possible for us to compare the smallest amount of detectible substance with the hypothetical mass of the molecule, that is with the smallest quantity of substance that is capable of existing. In this way we easily reach the perhaps surprising fact that the least quantity of mercaptan perceptible to the senses contains about 2×10^{10} molecules. Hence, even of the most penetrating odors, it is necessary for twenty billions of their molecules to bombard the olfactory nerves, before these carry the sensation to the brain; they utterly ignore all smaller quantities. In ordinary analytical methods the quantity of substance is naturally incomparably greater. Without undertaking to weary you with figures I will in general and briefly note that by micro-chemical methods it is possible to detect about one ten-thousandth of a milligram, while in ordinary test tube reactions, it is desirable to have at least several milligrams of the substance present.

And now we come to the consideration of the last of the problems mentioned. The processes by means of which we decompose the mixtures which nature furnishes us, into their individual constituents, that is obtain from them chemically pure compounds, are of many kinds. We make use of variations in solubility and volatility, of the possibilities of crystallization and diffusion, of chemical, electrical and magnetic relations. These are, in a single word, really gradual differences, which can be used so much the less perfectly as the bodies to be separated resemble each other in physical and chemical aspects. Purification thus appears a process that can only be worked by degrees, so that we can consider the absolutely pure body wholly as a limiting condition. In the natural sciences it is often desirable to obtain as closely as possible such limiting conditions: for example we may mention the absolute zero, the possibility of which is clearly deducible by a simple consideration of the law of Gay Lussac: the absolute vacuum, a conception usually derived from the fact that the quantity of substance in a given space can be more and more diminished; (we are on the other hand convinced with certainty that it is as little possible to obtain a true vacuum artificially as it is to conceive of it in interplanetary space). Again, the condition of absolute equality of temperature between two bodies in contact, or of a system which is in absolutely complete chemical equilibrium, are purely ideal limiting conditions, which, practically speaking cannot be attained. In this sense it is not possible for us to obtain any substance completely free from impurities, and we must therefore be contented to carry the purification as far as possible—a task with which chemist and physicist are employed. A few striking examples may be noted in this field, and especially those in connection with the name of Stas. At first for the purpose of carrying out his atomic weight determinations there was demanded exceptionally pure substances, and it was naturally necessary for him to devise the means of obtaining them. Later he took up the experimental proof of the problem which had been suggested by Lockyer as to the composite nature of certain metals, and for this purpose Stas prepared with the greatest care a series of pure salts. For example, after eleven years' labor he succeeded in preparing a specimen of potassium chlorid, in which it was not possible to detect by any means the slightest trace of sodium. The investigations of Kohlrauch and Heydweiller may be mentioned here. They undertook the preparation of pure water in order to be able to determine its electrical conductivity with the greatest possible exactness. These investigators were obliged to carry out their work in glass vessels, and under such circumstances we can but be astounded that they succeeded in obtaining water so pure that a liter contained the exceedingly small quantity of a few thousandths of a milligram of foreign substance. More recently W. Spring has been engaged in this same problem of the purification of water, and has thrown new light upon it. He has found that in all liquids which have been purified by distillation (that is, according to the methods commonly in use up to this time) small particles are still present which may be detected by optical methods, and which in some circumstances can be eliminated by an electrolytic process.

Thus these new and more accurate methods furnish results which now in one direction and now in another can be considered more exact, although the attainment of the limit, as already mentioned, must be regarded as impossible. In other words, we are not in a position to absolutely exclude from a given space which is filled with one substance a large number of other substances. Nevertheless perhaps, in a single instance it has been possible. To touch upon this briefly, we must notice the problem which has been handled with remarkable accuracy by Baker, an Englishman. Baker has set for himself primarily the problem of the relations of gases to each other in conditions of the greatest possible freedom from moisture. In passing it may be stated that these gases were kept in fused glass tubes for months in contact with the best drying substances, for example phosphorus pentoxid, and thereby acquired in most cases very remarkable properties.

Substances which in other conditions react upon each other with the greatest energy were perfectly indifferent. Thus the dangerous phosphorus, which generally takes fire in the air at a temperature somewhat lower than that of the body, can be distilled in oxygen ; and hydrochloric acid and ammonia gas can be mixed without indicating any reaction. How shall we reconcile these observations with our commonly accepted theories? Is there here an interval in the properties, and is this interval connected with a similar interval in the conditions; that is, have affinity and moisture here in fact become absolutely nil? It is indeed hardly necessary to assume that the affinity has become zero, for one can equally well account for the phenomena, if one assumes that the velocity of the reaction has diminished very greatly, as seems already to have been proved the case at very low temperatures and for a perfectly dry mixture of carbon monoxid and oxygen. Also against the assumption that in Baker's experiment the last molecule of water has been wholly removed may be cited the fact that the water which is contained in the metaphosphoric acid still possesses an extremely small vapor tension. Further, even if Baker's dried gases really undergo a sudden change in their chemical properties, it does not necessarily follow that at the same time a sudden change in the moisture shall be present. As a matter of fact, we know that the properties of matter often change in a very unexpected way when they are only in the vicinity of such a limiting condition. The electrical phenomena in tubes of high vacuum present a familiar example. From a theoretical standpoint the facts which have been mentioned, aside from the interest which they arouse from their strangeness, are also remarkable on another ground. This has reference to the different hypotheses which have been proposed as the cause of reactions. Among these we may note that of Armstrong, who assumes the presence of free atoms or ions and looks upon the conditions of reaction in gases, practically in a similar way to that demanded by the theory of Arrhenius and Ostwald for liquid electrolytes. By this the analogy which has been suggested between these two states of aggregation, and which at present dominates the thought in the province of inorganic chemistry, is rendered complete We may add to this that the remarkable observations, according to which gases under the influence of Röntgen and certain other rays become conductors just as if electrolytes, lead to the same conclusion. It shows us again in what close relationship the perfection of methods and of the experimental resources on the one side, and advancement in knowledge on the other, stand to each other. Experimental science and theory are a constant stimulus to each other and bring forth their fruit side by side.

And now I have come to the end of my proposed task. I have indeed spoken only from the standpoint of my own field; but I believe that the conclusions which are drawn from these considerations may be so far generalized that they appear of importance for the technologist also. The sciences on which his work rests are applied mathematics and applied natural science. The former can do its work wherever the latter has by experiment laid a foundation, and because thus in the improvement of methods and appliances results are being attained which are of increasing value, the technologist may take an interest, we may almost say an egotistic interest, in the successful development of the pure natural sciences. One thing further, of a more ethical nature may be suggested by the fundamental similarity of the problems in both departments. Just as we chemists labor to come as close as possible to the absolutely pure substance, or to some numerical value (atomic weight and the like), in the same way the machine builder strives for the conveyance of energy with the least possible loss, and the engineer for the lightest possible carrier.

And if indeed, the complete solution of these problems lies beyond the scope of our powers, if from the side of nature the inexorable 'No' stands against us; nevertheless, we have in our hands in the increasing accuracy of our methods of work the true philosopher's stone, by means of which we can ever come nearer and nearer to our goal. Let us look upon the creation of new methods of experimentation and the improvement of the old methods in our practical science, as one of the most important duties for those who seek for progress and see in the development of our powers of reason the foremost task of the cultured mind.

FRIEDRICH EMICH.

GRAZ, HUNGARY.

CORRESPONDENCE OF C. S. RAFINESQUE AND PROFESSOR WM. WAGNER.

IN hunting through the natural history material collected by the late Professor William Wagner in the Wagner Free Institute of Science, some fourteen years ago, I discovered several letters from the eccentric naturalist Rafinesque, together with a number of pamphlets written by him.

Professor Wagner had evidently taken up Rafinesque upon his return to Philadelphia from Kentucky with all the enthusiasm that a man interested in the development of the study of natural history must have for one who gave his whole time and all the money he could scrape together for the amassing of collections in every department of zoology and botany. It would appear from the context that Rafinesque had got into trouble (no unusual thing for him) and wished Professor Wagner to go on his note for the amount necessary to relieve him. This was promptly refused for the reasons given in Professor Wagner's letter, and Rafinesque writes to him on the 10th of April, 1840, as follows:

DEAR SIR:—I wish you will send me five dollars at y'r convenience for my 'Amenities of Nature' or at least One Dollar for the first Number that you have already had—that is the price. The value of Montford is $10. having 261 plates & with my notes $12. to 15; while Mantell is only worth $3.

I sell my works, my shells, my drawings and my services—I give them away sometimes to particular friends only, altho' I can hardly afford it.

Yours, &c,

C. S. RAFINESQUE.

Professor Wagner immediately replied on the 10th of April, 1840:

DEAR SIR:—Your note of this morning I found on my table on my return home at noon.

Your singular request to send you five dollars "at my convenience for your 'Amenities of Nature,' or one dollar for the one you say I have rec'd really surprises me. I now return to you unread, as my time has been otherwise much occupied that which you loaned me for my perusal and to which I never subscribed. If you have done perusing my copy of Mantell which, you informed me, you had read with interest & pleasure, you will please hand it to the bearer, as I wish to lend it to other of my friends. You inform me you sell your works, shells, drawings & services. I would beg leave to remark I have no occasion for any of them at present. You add "you give them away sometimes to particular friends only." I would add if you intend the remark for me you must know I never asked you for anything, neither have I ever received an atom of any of your property or effects, no not the most trifling, neither do I want them. I really regret my refusal yesterday to enter the requested security has produced an ebullition of feeling as your note indicates. I would have thought that your age and philosophy would have controlled your passions particularly after my explaining my reasons.

Yours, &c,

WM. WAGNER.

The reply from Rafinesque is dated April 12, 1840, and reads as follows:

MR. WILLIAM WAGNER.—The work of Mantell was delivered to your servant as you requested. I am used to disappointments—it was not an angry feeling but *sorrow* I experienced at your refusal;

sorrow that I had been mistaken in hoping I had acquired another learned friend. I had anticipated much pleasure from the study with you of the shells and fossils of y'r fine cabinet, as you tendered—you may now have that pleasure alone. I wish Conrad, Troost and others may be found willing to give you for nothing the use of their labors and discoveries, as I had proposed for my own; but I doubt it; Few are as liberal as I am. As you neither require my works, nor shells, nor fossils, nor labors *now*, I have wondered why you asked them before.

My time will thus be better employed perhaps in continuing my solitary labors. It is a pity that here naturalists will not be friends and labor jointly to increase knowledge. When you return from your intended travels we may resume joint studies, if you require it.

Respectfully yours,
C. S. Rafinesque.

On the 16th Professor Wagner writes:

Your note of the 12th was handed me this morning only. You still harp upon the disappointment you reced in my refusal to enter bail as you stated for your appearance only to prosecute an appeal which in reality was bail for debt, squire fees, court expenses, etc., in case of final defeat. If your boisterous manner and final departure without an ordinary adieu expresses sorrow (& what I considered anger) why you show your feelings very differently from anyone I ever saw. I expressly informed you I was retiring from business and this day we have advertised our stock for sale at auction and I have resolved that I would not contract any new liabilities, that I was closing everything and would avoid all new responsibilities. Any reasonable man would not have murmured at such an explanation. My article of copartnership independently of all other objections positively precludes my complying with your request. I regret that you should have thrown the obstruction in the way of our scientific intercourse and assure you that I was as much pleased with our friendly interchange of thoughts and opinions as you could possibly have been. You have caused the breach. Therefore it is for you to close it if you desire it. You again speak of giving for nothing your labor, your discoveries, etc. I never received any of your labors, or discoveries, or anything else. If you can show I have, send me a bill of it and I will pay your demands. The only transaction we have had was that I loaned you a book and you loaned me one. I cordially agree with you that any interruption of our joint studies by your extraordinary request is as disagreeable to me as it can be to you.

Respectfully yours,

The last letter comes from Rafinesque under date of the 17th of April, 1840.

Sir:—Y'r letter of yesterday did not require immediate answer, but having received two important letters from European geologists which under other circumstances would have been immediately shown to you, it may be proper to impart some of their contents. My Geological Fragments have been published by the first Geological Society of Europe. I am informed that American fossils (particularly of the oldest formations) are very scarce in European collections and wanted for sale and exchange. I am instructed to apply to you and others for specimens but all of mine are required. Muchinson (?) and a friend of mine are going to publish jointly the whole silurian system of Europe and all such American fossils of that age they can procure, therefore as you have stated you no longer want my fossils and have perhaps given up y'r idea of undertaking the American silurian system—I propose to send to Europe this year the whole of my American fossils amounting to thousands and of great value—of which it is proper you should be apprized in time. If you should go to Europe instead of the South and West and carry your fossils there, I will be able to inform you further. I shall no longer *harp* as you say on my disappointment I have merely to remark that as a candid man I prefer a direct refusal to pretext. That you may be undeceived ab't your apparent surmise, I must add that I don't owe one dollar to anybody, and pay all just demands. It was never stated that you received any of my labors and I don't send false bills to anyone. My herbarium was all around us at my office and you never asked to peep into it. My fossils and shells are in boxes as I cannot spend large sums like you to display them. They have been tendered for drawings only at y'r own request, a great favor you ought to know; but next year shall be in Europe where valued and paid for in the equivalents. As I have many duplicates if you will exchange them immediately with some of y'rs I have no objection—Price for price.

Respectfully y'rs,
C. F. Rafinesque.

These letters would seem to be almost childish but for the fact that Rafinesque had been for several years thoroughly eccentric in his actions and this was probably the beginning of the miserable end.

They were probably written when he lived on Race Street in a garret. If he died on September 18, 1840, as is stated by R. E.

Call in his 'Life and Writings of Rafinesque' these must have been written but five months before his decease and his quarrel with Professor Wagner probably ended his scientific associations in this City.

In looking up the date of his death I have been struck with the fact that Lippincott's Biographical Dictionary, Simpson's 'Lives of Eminent Philadelphians' and Appleton's Cyclopedia of American Biography quote the date of his death as September 18, 1842 and the National Cyclopedia of American Biography is the only authority that I can find for the year 1840, which is used by Call.

THOMAS L. MONTGOMERY.
WAGNER FREE INSTITUTE OF SCIENCE,
March 2, 1900.

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*SOME OBSERVATIONS CONCERNING SPECIES AND SUBSPECIES.**

SOME few weeks ago I gave to this Society a brief general account of the investigations which the Fish Commission carried on at Lake Maxinkuckee during the past summer and fall.

At this time, I desire to speak briefly concerning two new fishes obtained in these investigations, and certain questions concerning species and subspecies which their study has suggested.

In the first place, permit me to repeat some of the statements regarding the lake and its small tributary streams.

Lake Maxinkuckee is located in the southwest corner of Marshall County, Indiana, on the Logansport and Terre Haute railroad, 32 miles north of Logansport, or 34 miles south of South Bend, Indiana. It is about 2.75 miles long, from north to south, 1.75 miles wide, and is quite regular in outline. This, like all the lakes of northern Indiana, is of glacial origin. Its greatest depth, so far as known, is 86 feet. The bottom is of compact sand and gravel near the shore, then a wide bed of marl, and soft mud in the deeper parts. There are only 1 or 2 short reaches near the shore where the bottom is soft. The water is relatively pure and clear. The bottom temperature in summer is 47° to 50° Fahr., while the surface gets as warm as 77° to 80°.

The lake is well supplied with aquatic vegetation; *Chara*, *Potamogeton*, *Myriophyllum*, *Ceratophyllum*, *Nitella*, *Vallisneria* and *Scirpus* being abundant. At least ten species of *Potamogeton* occur and two species of *Scirpus* are found. *Chara* is very abundant, great beds of it covering the bottom in many places from near shore out to a depth of 12 or 15 feet.

The catchment basin of the lake is small. There are no tributary streams except one very small brook at the south end, a somewhat larger one at the southeast corner, and three small ones upon the east and northeast sides. The total amount of inflow from these little creeks is but a few gallons per minute. They are all short, sluggish streams and do not vary greatly in size at any time. Perhaps the only ones deserving mention are (1) the one at the southeast corner which is popularly known as 'the inlet,' (2) one near the middle of the east side, and (3) one at the northeast corner flowing into Culver Bay, and which has come to be known as Culver Inlet. The stream on the east side has been called Aubeenaubee Creek, from the Pottowattomie chief of that name who at one time owned the land on the east of the lake. It was from this small creek that the specimens of the new species were obtained. Aubeenaubee Creek does not exceed 1.5 miles in length. It has its source in a small marsh, and is a sluggish stream flowing through a low, level meadow or prairie region. It is about 4 feet wide and averages only 3 to 6 inches deep, with deeper holes at intervals. Through most of its

* Read before the Washington Biological Society, Jan. 26, 1900.

length the stream is overhung by bushes and briars, and is full of sticks and brush. The bed and banks are of black mud with a mixture of sand. In some places the ground is quite boggy. The midday summer temperature of the water in this stream is about 72°. The species of fishes found in this stream are almost wholly different from those found in the lake proper, a fact illustrating clearly the importance of even slight differences in geographic location if accompanied by stable environmental differences. The principal fishes occurring in this creek are *Semotilus atromacalatus, Campostoma anomalum, Umbra limi, Lucius vermiculatus, Notropis cornutus*, and young *Micropterus salmoides*. Crawfishes were abundant.

The two new fishes discovered are both darters, one belonging to the genus *Hadropterus* and the other to the genus *Etheostoma.*

I may say, in passing, that the darters are members of the Percidæ or Perch family, to which belong the walleyed pike, the Sauger and the Yellow perch. Sixteen genera and 85 species of darters are recognized. They are all small, active fishes, usually brilliant in coloration and have much the same position among fishes that the warblers have among birds.

Both of the new darters obtained at Lake Maxinkuckee were found in Aubeenaubee Creek and nowhere else.

The nearest relative of the species of *Hardopterus* is *H. scierus*, which, though not known to occur in Lake Maxinkuckee, is found in Yellow River of the Kankakee drainage, only a few miles north, and also in Tippecanoe River five miles south of the lake. The form found in the creek is well set off from its nearest relative and is described as a species.

The other darter, described as new, is evidently derived from *E. iowæ*, which is found, not only in many of the streams of western Indiana, but also in Lake Maxinkuckee in some abundance. It is, however, not known to occur in Aubeenaubee Creek.

Etheostoma iowæ, in extending its range from its original center of distribution, in all probability, found its way into Lake Maxinkuckee from the Tippecanoe River. Having once become established in the lake, individuals sooner or later began entering its tributary streams. Among the individuals entering Aubeenaubee Creek there were some that, finding the conditions easy, remained and bred there, and thus a creek colony was established. It is altogether probable that for some, possibly many years, individuals from the colony would occasionally return to the lake and interbreed with individuals that had never left the lake. And the reverse would also take place: individuals from the lake would probably continue for many years to invade the domain of the creek colony and interbreed with its members. Under conditions such as these, the members of the colony going farthest toward the head of the creek were probably the ones which soonest became free from the influence of the lake and, breeding only among themselves, were modified most rapidly by the new environment. In time they became so well differentiated as to render them readily distinguishable from the parent form in the lake. During the continuance of the conditions mentioned, however, the migration and countermigration between the lake and the stream, there would be found in the lower part of the stream and in the lake about its mouth, the progeny of the individuals from the lake and creek which had interbred. These would possess characters more or less intermediate between the parent species (*E. iowæ*) and the derived form inhabiting the creek. So long as these intermediate forms continued to exist, the form found in the creek would be only an incipient species. As an incipient species it would be a subspecies of *E. iowæ*, and would receive a trinominal name.

But if, in the course of time, invasions of one habitat by individuals from the other should cease, then the intergrading forms would, through interbreeding with the extreme forms, be gradually absorbed by them and finally disappear altogether. In the creek would then be found a form differing clearly and constantly from the lake form and without any connecting forms. Under these circumstances the form in the creek, as well as that in the lake, must rank as a distinct species.

This is the present condition, so far as our investigations have enabled us to determine. There is no difficulty in distinguishing individuals taken in the lake from those found in the creek, and neither form seems to invade the habitat of the other. Large collections were made, not only of the fishes inhabiting the lake, but also of those in the creek. The latter was carefully seined twice, from its source to its mouth, and not a single example of *E. iowæ* or any form showing intergradation was seen. Similarly careful investigations were made in the lake without discovering any individuals of the creek form or any showing intergradation. Whether further collecting will discover connecting forms cannot, of course, be stated. The small size of the creek and of the lake, and their close geographic relation, render it almost certain that individuals of the one form would occasionally invade the habitat of the other, and *vice versa*. While the environment of the creek is markedly different from that of the lake, it is improbable that a change from one to the other would prove disastrous to the individuals concerned. Some of such individuals would, it seems, be able to survive, and some would probably interbreed with individuals of the other form whose habitat they had invaded. This was, quite likely, the condition in the beginning, and the creek form, so long as it remained connected with the parent species by the intergrading forms resulting from such interbreedings, would be a subspecies of the parent species. But, as already stated, no such connecting forms have yet been found and the form inhabiting the creek is a distinct species.

There is one other possible condition worth considering. Let us suppose that, after the creek colony had become well established, and for many generations had not intermingled in any way with the parent species in the lake, the habits of one or the other, or both, should change somewhat and that they should again begin to invade each other's habitat and to interbreed. The result of this interbreeding would be the appearance of individuals possessing morphological characters more or less intermediate between the lake and the creek forms. In other words, individuals would be found showing that the two forms intergrade and placing them again in the relation of species and subspecies. If we could *know* this to have been their history, however, we should certainly not place them in the relation of species and subspecies. We should regard them as two distinct species, and the individuals which seem to show intergradation we would call hydrids, which they really are. But we can rarely, if ever, *know* that such has been the history. So long as intergradations are found connecting the two forms, the one last discovered must be regarded as a subspecies of the other. In the present case, however, no intergradations seem to exist, and the relation is that of two distinct species. While the occurrence in nature of hybrids is doubtless very unusual, such a condition as the one supposed is certainly not improbable.

And this suggests a further consideration of subspecies. An examination of the descriptions of forms which have been published as subspecies does not show that the describers have all been governed by the same principles, or that all who have described subspecies have had very well-defined ideas as to what a subspecies really is. I am sure that I myself have given trinominal names to new forms with rather hazy ideas upon the relation of species and subspecies.

The present practice of most systematists in this country seems to be to regard any two given forms as distinct species, unless they are known to possess morphological characters which intergrade. If characters showing intergradation are present, the one later described is regarded as a subspecies of the other. The intergrading may be of two kinds of categories:

1. It may be associated with the known joining of the two respective habitats. In this case the individuals possessing the intermediate characters would come from the region where the two forms, or the habitats of the two forms, join or overlap. If *E. iowæ* were known to intergrade with the *Etheostoma* of Aubeenaubee Creek, the connecting forms, if of this category, would be found in the mouth of the creek, or in the lake near the mouth of the creek. This, it seems to me, would be a good example of what we mean by a subspecies.

2. In the other case, the two habitats do not join, but an examination of a series of specimens from each will show an intergradation of characters. Though the sum total of the characters is different, individuals will be found in one series which possess, in varying degree, all the characters shown by those of the other. The individuals showing the intergradation come from the same localities from which have been obtained the typical individuals. They do not come from intervening localities because the habitats do not join.

Is it correct to regard these two forms as sustaining the relation of species and subspecies?

Trinominal names have, in many instances, been given because the differences separating the form under consideration from some previously-known form are slight. But now, the almost uniform practice seems to be to regard constant differences, however slight, in the absence of known intergrading forms, as of specific value; and differences, however great, if known to intergrade, to be only of subspecific value.

If this view be correct, there are many trinominals in current faunal and floral lists which are there without sufficient warrant. In the latest systematic work on American fishes 3255 species and subspecies are recognized. Of these, 125 are ranked as subspecies. But an examination of the facts regarding each shows that very few of them should stand as subspecies, but as species. They have, in most cases, been called subspecies simply because they differed but slightly from the most closely related species. I doubt if intergradation is *known* to exist in 25 per cent. of the cases.

I have been told that many of the trinominals in current use in ornithology rest upon the same insufficient evidence.

It is the practice of some, I believe, to describe as subspecies forms which, though not *known* at the time to intergrade, will in all probability, be found to do so. The describer's knowledge of the group to which they belong, the principles of geographic distribution, and the geography of the country in which they are found, justify him in anticipating the evidence of actual intergradation.

Personally, I doubt if this is the best course to pursue. Would it not be better, either to wait until the evidence is in hand, or describe the new form as a species?

We sometimes hear the remark that systematists often go too far, and describe as new species or subspecies forms which differ but slightly from known forms; that they give specific or subspecific value to differences which are due merely to some slight difference in environment. This, it seems to me, misses the whole point. What produces species and subspecies, anyway, except slight differences in environment, together with greater or less geographic isolation? And when we see these differences why should we refuse to admit their existence or their meaning?

Barton W. Evermann.
U. S. Commission of Fish and Fisheries.

BREATHING OXYGEN.

The experiments here described were carried out during the course of an investigation to determine the quantity of carbon dioxide exhaled from the lungs of different persons under stated conditions.

The method of procedure was as follows: (1) Ordinary air was inhaled through the nostrils and exhaled through the mouth (the nostrils being closed) into an inverted receiver filled with water. The quantity of carbon dioxide in the exhaled gases was determined in the usual manner. (2) A mixture of air and oxygen containing 26.4 % of oxygen was inhaled and exhaled as in (1). (3) Pure oxygen was employed and the experiments conducted as in (1) and (2).

The breathing experiments were made by three different persons, A, B, and C, under conditions as nearly indentical as possible. The following results were obtained:

A		B		C		
Exp.	CO_2	Exp.	CO_2	Exp.	CO_2	
1	3.8	10	3.6	19	3.8	Ordinary air.
2	5.2	11	4.4	20	5.1	
3	5.6	12	4.6	21	5.8	
4	4.0	13	4.0	22	4.0	Air and oxygen.
5	5.6	14	5.2	23	5.4	
6	—	15	5.6	24	5.6	
7	4.2	16	4.8	25	4.4	Pure oxygen.
8	5.8	17	5.6	26	5.8	
9	6.2	18	6.2	27	6.4	

The figures given express percentages by volume; they are lower than those that would be obtained if the exhaled gases were collected over water saturated with carbon dioxide. The object of the experiments was to get relative rather than absolute values. In experiments 1, 4, 7, 10, 13, 16, 19, 22 and 25, the gas (air, mixture of air and oxygen, or oxygen) was inhaled for five seconds and then exhaled for five seconds.

In experiments 2, 5, 8, 11, 14, 17, 20, 23 and 26 the lungs were inflated as fully as possible with the gas, which was retained *fifteen* seconds and then exhaled.

In the other experiments, 3, 6, 9, 12, 15, 18, 21, 24 and 27, the lungs were fully inflated and the gas retained *thirty* seconds before exhalation.

William B. Schober.
Lehigh University.

THE SOCIETY OF AMERICAN BACTERIOLOGISTS.

The following are abstracts of papers read at the first meeting of the Society of American Bacteriologists, held at New Haven, December 27th to 29th.

Natural varieties of Bacteria: Professor H. W. Conn.

Professor Conn exhibited some cultures of a highly variable Micrococcus which he had isolated many times from milk. Its color ranged all the way from a snow white to a deep orange, and in power of liquefying gelatin it ranged from a form that liquefied with great rapidity to one that had apparently no liquefying power. All these varieties, with numerous intermediate stages, have been found in nature and are not the result of cultivation. Professor Conn showed, however, what a great change can apparently be produced in the character of a species, by a simple process of selection. Starting with a pure culture of this organism, he was able to produce from it a white and an orange culture, by simply replating many times, and selecting the whitest color, on the one hand, and the yellowest, on the other. At the same time, by selecting the colony which liquefied most rapidly and the one which liquefied most slowly, he was able to obtain from the same original culture, rapidly liquefying cultures, and those with hardly any liquefying power. He raised the question whether many of the changes which had been described as due to changed environment, might not really be due to such unconscious differentiated selection.

The significance of varieties among Pathogenic Bacteria: PROFESSOR THEOBALD SMITH.

In the study of bacteria, morphological details are of but little value in differentiating and classifying forms because of their minuteness. Processes of conjugation and other sexual phenomena, such as are found among Protozoa, are unknown.

The problem of variation may be discussed under these heads:

1. The actual existence of bacteria whose relationship is conceded, although they manifest slight differences among themselves.

2. The artificial modification of bacteria by experiment.

3. The evolution of parasitic from saprophytic forms.

In the investigation of problems of this character it is necessary to study, not only the effect of related bacteria on the same host, but that of the same bacteria on different hosts. Our investigations should be both experimental and comparative.

(The variations occurring in the group of bacteria of which the rabbit septicæmia bacillus is the type, and those occurring in the pathogenic derivatives of the colon group, were discussed and illustrated. Variations among tubercle bacilli, in form and virulence, and among diphtheria bacilli, in the production of toxin, were also referred to.)

The modifications which bacteria undergo, during passages through animals, vary in degree with the species and group under observation; with some, such as the rabbit septicæmia bacilli, streptococci, and pneumococcii increase in virulence is easily attained; with the colon group this is much more difficult. The degree of change that can be impressed upon any bacteria probably depends largely on the specific structure of the organism.

The evolution of parasitic from saprophytic forms is a very slow and gradual process, whose mechanism may have differed with different species. Special advantages which a certain environment may offer for frequent passages through susceptible species may give certain saprophytes an impulse towards a parasitic existence. In any case, such saprophytes probably possess from the outset certain fighting characters, such as the power to produce toxins which enable the few among the myriads of forms, eventually, to become disease germs. (Published in the *Journal of the Boston Society of Medical Sciences*, January 16, 1900.)

Methods employed in the teaching of Bacteriology: PROFESSOR H. C. ERNST.

In response to a circular letter sent to the Institutions of Learning that teach medicine, as given in the 1899 volume of *Minerva*, there were returned ninety-eight replies. The letter asked for information as to whether Bacteriology was taught as a separate branch—in case it was not, in what department it was included—how many instructors were engaged in teaching this subject—the hours required—and other details of interest. It was found that forty-two institutions give instruction in Bacteriology as a separate department—twenty-six give separate courses, in connection with the department of Hygiene, and thirty-seven in connection with the department of Pathology, or Pathological Anatomy.

The increase in the numbers of teachers

of bacteriology in connection with medicine was noted, over the condition as found in the first volume of *Minerva* (1892).

(The full details of this investigation will be found in the *Journal of the Boston Society of the Medical Sciences*, Vol. IV., p. 67 et seq.)

On the changes of opinion in England in favor of bacterial purification of sewage: PROFESSOR L. P. KINNICUTT.

Professor Kinnicutt described recent experiments conducted in England which are producing a change in opinion as to the best method of treating sewage. Whereas, hitherto the chemical method of treatment has been commonly used, the belief is now rapidly gaining ground that the purification of sewage by bacterial growth offers the cheapest and most efficient method of purifying it so that it may be discharged into rivers without polluting them.

Recent work on sewage purification involving bacteria: H. W. CLARK.

The paper brought out clearly the fact that the benefit derived from preliminary anærobic bacterial action upon sewage before filtration has been recognized at the Lawrence Experiment Station for several years, and calls attention to statements made, and investigations upon this point recorded in the reports of the Station for 1895 and 1896 (see report of Massachusetts State Board of Health for these years). It gives credit to Cameron for first practical use of anaërobic action with his septic tank at Exeter, England. Results of investigations upon production and purification of septic sewage at the Lawrence Experiment Station during 1897 and 1898 were given, with a comparison of intermittent sand filters and bacterial or contact filters. Rates of filtration of septic sewage, equal to 300,000 gallons per acre, have been attained with sand filters at Lawrence, and of 800,000 with contact filters, with satisfactory purification. Investigations at Lawrence during 1898 have shown that open septic tanks are as successful as those made air-tight, owing to the scum of bacterial growths, fat, etc., formed over the surface of the sewage. Some experiments made at the Station seem to indicate strongly that anaërobic action may be carried to such a point that the resulting sewage is very difficult to purify.

The paper also gave the result of an experiment in which sewage during 1898 was passed through a filter of broken stone ten feet deep, at the rate of one million nine hundred thousand (1,900,000) gallons per acre daily, with very satisfactory results, nitrification being active, purification satisfactory, and the rate of filtration more than twice as great as ever before attained at Lawrence with crude sewage.

The significance of the appearance of B. Coli communis in filtered water: H. W. CLARK and S. D. M. GAGE. (Read by H. W. Clark.)

The purification of polluted waters by sand filtration has been studied at the Lawrence Experiment Station for the past thirteen years. Up to the beginning of 1897 the efficiency of the filters in removing bacteria was ascertained by determinations of the actual number of bacteria in the water applied to the filters and the effluents from them. For the past three years determinations of the number of *B. coli communis* in the applied water and effluents have been made. Especially has the efficiency of the Lawrence City Filter in removing this germ from the Merrimac River water been carefully followed. This was done, as it was believed that the significance of the appearance of the germ in the filtered water could be determined because of the opportunity presented of studying its appearance in connection with the occurrence or non-occurrence of cases of typhoid fever in the city of 55,000 inhabitants using this filtered water.

This city filter was built in 1893, and, while the death rate from typhoid fever in Lawrence for a number of years before its construction averaged about 12 per 10,000 inhabitants; the first year after construction the rate was 4.75 per 10,000 inhabitants, and this was followed by a steady yearly decrease to 1.39 in 1898. During this period there was no unusual disturbance of the sand filter bed, and its bacterial efficiency was good.

In the fall of 1898 it was necessary to relay some of the underdrains of the filter, and some of the sand beds were very much disturbed. When the sand was replaced and water was again passed through the filter the entire effluent was pumped to the reservoir and used in the city. Following the conclusion of this work, *B. coli communis* was found in 1 c.c. of 72 per cent. of the samples of the effluent of the filter examined during December; 54 per cent. of those examined during January; 62 per cent. of those examined during February; and 8 per cent. of those examined during March. The bacterial efficiency of the filter, or percentage removal of total numbers of bacteria in the applied water, was 92.20 per cent. from December 10th to 31st; 98.31 per cent. in January; 98.17 per cent. in February; and 99.89 per cent. in March.

During the period from the end of the disturbance of the filter in December until the end of the month there were twelve cases of typhoid fever reported in the city; during January, 59 cases; during February, 12 cases; but in March, when *B. coli communis* had practically disappeared from the effluent of the filter, there were but 9 cases, and these during the first portion of the month; that is, during the months of December, January and February there was an epidemic of typhoid fever in Lawrence. During this period, *B. coli* was present in 1 c.c. of samples of effluent of the filter examined to the extent denoted by the figures given. When it failed to be found in 1 c.c. the epidemic had ceased. When 100 c.c. of the effluent were examined, *B. coli* was found more frequently, but the figures and facts in regard to the epidemic seem to show that, when filtering a river water as polluted as that of the Merrimac, it is safe to assume that, when *coli* is found only infrequently in 1 c.c. of the effluent, the typhoid germs, necessarily fewer in number, and more easily removed by the filter, have been eliminated from the water. The death rate of the city from typhoid fever in 1899 was 3.00 per 10,000 inhabitants.

On the detection of bacillus Coli communis in water: Professor E. O. Jordan.

The direct application of the fermentation tube method to greatly polluted waters sometimes meets with a serious difficulty. This is the fact that other gas-forming species (and perhaps some non-producers of gas) overgrow *B. coli* and obscure or falsify the typical reaction. This appears to happen at least with some river waters more commonly than has generally been supposed, even when extreme dilutions are employed. One species that interferes often with the growth of *B. coli* is a variety of *B. cloacæ*, and when mixtures of pure cultures of this microbe and of *B. coli* are introduced together into fermentation tubes, the former frequently gains the upper hand.

A method that has given promise of overcoming this difficulty, and some others, is the following. The desired quantity of water is incubated in acid carbol broth, 1. c.c. of the required dilution being added to 5 c.c. of broth made 5 to 5.5 acid on Fuller's scale, and containing carbolic acid in the proportion of 1–1000. After inoculation at 38°–40° for 12 to 18 hours, platings are made in litmus lactose agar, and colonies reddening this medium are tested for coagulation of milk, indol production, liquefaction of gelatin, and gas production in glucose broth. A recent comparison of the two methods has given the following results:

	Positive results.	Negative results.
Fermentation tube direct	21	34
Acid carbol broth	26	24

Although the number of experiments is small, the results indicate the distinctly greater delicacy of the latter method when applied to the waters used in these tests. The application of this method is interfered with, to some extent, by the same species that complicates the result in the fermentation tube, but the use of the litmus lactose agar facilitates the separation of *B. coli*, especially if the plate be examined within 24 hours after the sowing.

Demonstration of Actinomycosis and the Causative Fungus: PROFESSOR H. C. ERNST.

A specimen of very marked affection of the udder with the Actinomyces fungus was reported. Attention was called to the comparative rarity of the disease in this marked form, and the fact that the textbooks say but little about it as a possible source of infection. A number of microscopic preparations were demonstrated. (This case is also to be published in the *Journal of the Boston Society of the Medical Sciences*, Volume IV.)

A comparison of B. Coli communis from different species of animals: V. A. MOORE and F. R. WRIGHT. (Read by F. R. Wright.)

Different forms of *Bacillus coli communis*, from contaminated water supplies and variations of the same organism in tissues of different species of animals, have led to this investigation to determine the range of variation of *Bacillus coli communis* in (1) different species of animals, and (2) in the same species, always under supposedly healthy conditions. As the work was not begun until late in the summer, this paper is to be regarded only as a report of progress.

The methods which were followed were:

(1) To take a loop-full of the mucus from the large and small intestines and inoculate a series of gelatin plates from each.

(2) To make sub-cultures from six typical spreading colonies which appear the same.

(3) To replate from these sub-cultures, to make sure of no contamination.

(4) From the second series of plates to make sub-cultures in the special media.

(5) To determine the pathogenesis by inoculating such experimental animals as the rabbit and guinea pig.

Thus far the results have shown that the organisms found in the horse, the dog, the cow, the sheep, and the hen, are more numerous in the large than in the small intestine.

The number of colonies from the same part of the intestine of the same species varies much, *e. g.*, in the large intestine of the horse, in some cases the colonies have been too numerous to count; again, there have been four or five hundred, and again, no more than a dozen. Where the number of *colon bacillis* was greatest, other species were few; where they were few, either a fungus or a micrococcus predominated in numbers. The most marked variations in the organism from the different species have been in the changes which they produced in milk, and in the various sugars and in their pathogenesis. The range of variation of the bacillus from the same species of animals has been found to be narrow.

The invasion of the Udder by Bacteria: ARCHIBALD R. WARD.

The extent to which lactiferous ducts of the cow's udder are invaded by bacteria, was determined by means of bacteriological examinations of the udders of nineteen freshly slaughtered milch cows. Owing to the prohibitive expense of studying the udders of sound cows, it was deemed expedient to use those of cows slaughtered after condemnation by the tuberculin test. So far as possible, the udders of only slightly diseased cows were used. Samples of the fore milk were taken, and before slaughtering, the udder was milked as thoroughly as possible. The udder was removed from the carcass immediately after death and taken to a sheltered spot, for the bacterial examination. In each quarter in successson, a flamed knife was used to make an incision extending from the dorsal to the ventral region of the gland, and of such depth as to expose the tissue in the vicinity of its vertical axis. Bits of the glandular tissue were transferred with aseptic precautions to tubes of gelatin, and properly labeled to show the region from which the culture was made. After returning to the laboratory, the gelatin was liquefied at a gentle heat and poured in Petri dishes. By comparing the colonies appearing on the plates after several days, with those in cultures made from fore milk, it was possible to show that the same organism may occur in the fore milk in all parts of the udder.

The evidence appears to warrant a modification of the statements concerning the place at which milk first becomes contaminated by micro-organisms.

The writer concludes that, while milk is sterile when secreted, it may immediately become contaminated by the bacteria which normally inhabit the lactiferous ducts of the udder. (Published in Bulletin 178, Cornell University Agriculture Exper't Station.)

Exhibition of cultures and stained specimens of plague bacillus from two cases of Bubonic plague admitted to New York harbor, November, 1899: WM. HALLOCK PARK, M. D.

Three slides were shown. The first was from a twenty-four-hour agar culture showing, among rather short thick bacilli, peculiar long thick thread forms. The second was from a twenty-four-hour bouillon culture showing short almost coccus forms in chains. The third was from the spleen of guinea pigs dying of septicæma, showing characteristic darker staining of the ends of the bacilli. Cultures were also shown on agar and gelatin. These cultures were of especial interest in that they were obtained from two persons, the captain and the cook, who arrived on a steamer from Santos, Brazil, in December, 1899, where the plague was prevalent. The two men when they arrived showed simply a large bubo in the lower inguinal glands. The temperature was nearly normal, and they did not feel ill. They had been sick about eleven days. They obtained the infection from a companion who had died and whom they nursed. Pus was removed from these bubos with a hypodermic needle. The pus from both cases contained the bubonic bacilli although in small numbers either living or dead. In culture they grew exactly like two other cultures which Dr. E. H. Wilson had obtained from India. Their violence was slightly greater than Dr. Wilson's cultures.

Some suggestions on the study of systematic bacteriology: FRED'K D. CHESTER.

Attention is called to a work now in progress in the arrangement of the better known species of bacteria. Certain typical forms or species of bacteria exist. These latter present certain definite morphologic, biologic, cultural, and perhaps pathogenic characters, which establish the types, independent of minor variations.

The most marked of these types become the centers of groups, around which are gathered related species and varieties.

Migula's system is followed as the basis or generic classification.

Tables were shown, giving arrangements of the bacteria in groups.

The necessity of some system of terminology for use in descriptive bacteriology was urged, and a table of definite terms presented. The question of nomenclature of species was discussed. Little or no regard has, in many instances, been paid by bacteriologists to the most ordinary rules of botanic nomenclature. This and the lack of knowledge concerning the synonomy of species has led to improper naming.

This was illustrated by a number of examples.

A new pathogenic fungus—the sporothrix of Schenck: PROFESSOR LUDWIG HEKTOEN. (Read by Dr. Jordan.)

Schenck has described a case of subcutaneous, refractory abscesses, caused by a fungus which Erwin F. Smith tentatively assigns to the genus *Sporotrichum.*

In the case of a boy, five years old, under the care of Dr. Perkins of Shenandoah, Sava., an identical fungus was found to produce similar, refractory lesions as those described by Schenck; the process started in an abrasion of the left index finger, caused by a blow with a hammer, and during the next two to three months over twenty-five abscesses appeared under the skin and forearm. Ultimately, recovery took place.

The fungus was obtained in pure culture on two different occasions. It grows well in ordinary media, forming in the older agar cultures brownish, wrinkled and folded layers. Gelatin is slowly liquefied. Ærobic. Thermal death point about 60° C. It has a separate branching mycelium; clusters of five or six spores appear around the ends of the branches and single spores develop along their sides. The spores are ovate or apiculate, from three to five mikrons in their longest diameter. Grams stain positive.

It produces chronic suppuration in the skin of mice and extensive ulcers; small, chronic abscesses may develop in the abdominal lymph glands after subcutaneous injection. In white rats intra-abdominal injection is followed by the development of numerous nodules enclosing small abscesses; the pus is thick and viscid, and contains oval and oblong gram-staining bodies in large numbers, but no thread. Pure cultures of the fungus are readily obtainable from lesions both in mice and rats.

Rabbits, guinea pigs, dogs and pigeons are immune. In guinea pigs and dogs, small subcutaneous abscesses sometimes form after injection under the skin.

The importance of bacterial tests in the sanitary supervision of milk supplies: MARSHALL O. LEIGHTON.

The investigations taken as a basis for this paper were made during the three years ending June, 1899, under the authority of the Board of Health of Montclair, N. J. Seventeen dairies were included in the report, the bacterial tests in each being confined to the determination of 'numbers per cubic centimeter.'

The average results for each dairy during the whole term divided themselves into three classes: First, those dairies having an average below 15,000; second, those between 40,000 and 70,000, and third, those above 180,000.

Comparing the foregoing results with the dairies themselves, as shown by stereopticon views of each, it was found that the dairies in class No. 1 were of the most improved type, in which the utmost cleanliness prevailed. Representing class No. 2, poorly equipped dairies were shown, in which the owners plainly endeavored to do their utmost with the crude means at hand to produce a pure product, but were unable to provide proper sanitary appliances to aid them; while class No. 3 represented those dairies in which neither good equipment nor good intentions prevailed, but in which ignorance and indifference combined to produce poor dairies and unwholesome supplies. The comparison between the results of the determinations and the sanitary condition of the dairies was plainly marked in the photographic plates thrown upon the screen.

The practical importance of such an investigation was demonstrated in the publication of each year's results in the annual reports. The public have given them serious consideration and, in consequence, no less than a dozen unworthy dairymen have found their business unprofitable. In addition to this, several dairies have undergone a complete change in construction and in methods of production, and the supply as a whole had been raised to a high standard of purity.

Notes on the effect of blood serum from tuberculous animals and men on the tubercle bacillus when mixed with it in the culture tube and hanging drop: Dr. W. H. Park.

The serum was obtained through blisters from twenty-four persons, twelve having tuberculosis, and twelve not having any sign of the disease. The tubercle bacilli from a recent culture were ground up and a fine watery emulsion made. To this emulsion, divided into separate tubes, was added the serum from the different cases, to an amount such that in each case a 10 per cent. solution of serum resulted. Although in some the film forming on the slanted tubes was more tenacious than in others, no difference on the whole was seen between the dilution of serum from tubercular cases and that from non-tubercular ones. The result on the whole did not seem to offer much practical help.

On the bacteriology of canned goods, with a detailed account of bacteria detected in sour corn: S. C. Prescott.

The paper described some investigations upon the bacteria present in preserved cans of corn which had become spoiled and 'swelled.' The cause of the trouble was found to be the presence of certain species of bacilli which resisted the temperature used in canning the corn. The same bacilli were found upon the fresh corn and husks.

Experimental and statistical studies on the influence of cold upon the bacillus of typhoid fever, and its distribution: W. T. Sedgwick and C. E. A. Winslow. (Read by Mr. Winslow.)

A review of the literature on the subject of ice-supply and the public health shows that, while pollution of ice-ponds appears to have caused intestinal disturbance, no epidemic of typhoid fever has been satisfactorily traced to such a source. While it is known that cultures of the typhoid fever germ are not sterilized, the important question of the quantitative reduction of this species by freezing has been studied in only two limited investigations. The authors have, therefore, frozen large numbers of tubes of water inoculated with four different races of the typhoid bacillus, and determined the reduction after various periods. The results, twenty tubes being averaged for each period, show a rapid reduction in the first hour in freezing, varying from 30 per cent. in one culture to 60 per cent. in another; the reduction then proceeds approximately with the time of freezing, reaching a constant value of over 99 per cent. in two weeks. The last two or three germs per thousand appear to be very resistant, some remaining after twelve weeks of freezing. The four races used show constant individual differences in their susceptibility to cold. Alternate freezing and thawing was tested and found only slightly more destructive than continuous freezing. The destruction of the germ in cool, but unfrozen water, followed the same laws, actual freezing causing only a slightly greater reduction than a temperature just above the freezing point. Finally, a few experiments on the formation of ice on a free surface showed that 90 per cent. of the germs present were excluded from the ice by physical processes. The authors conclude that the danger of typhoid infection from the small fraction of weakened germs remaining in natural ice is probably not a serious one, and that the results of their experiments are in harmony with the facts of experience.

H. W. CONN,
Secretary.

SCIENTIFIC BOOKS.

Psychology and Life. By HUGO MÜNSTERBERG. Boston, Houghton, Mifflin & Co. Pp. xi+286.

Professor Münsterberg has here gathered together a number of essays, and has given to the collection the title of the first of the papers. The others are discussions of the relation of Psychology to Physiology, Education, Art, History and 'Psychical Research,' respectively. The chapters thus have a common starting point in Psychology from which they veer off in different directions. The author's special comments in these many fields it is impossible to reproduce here even in outline; we must confine ourselves to the more general doctrine presented in the work.

The book is in many ways an exposition, or at least the hint, of a philosophy; and to deal with it adequately would take one inevitably into deep water. With his main contention that Psychology is but a partial way of dealing with the mind, the present writer feels entire sympathy. It is important to have it put strongly by a psychologist that when we shall have catalogued all the facts of our mental life and have discovered their causal order—which is the purpose of psychology—there still remain the larger questions which have to do with the value and meaning of these occurrences. Psychology, like any natural science, is concerned merely with the facts; its aim is to describe and explain things; and to this end leaves out of account the all-important problem of what our consciousness signifies or what its ideals should be. The things we perceive, he is fond of saying, merely 'exist' but are not 'real'. For this reason the real mental life—the life of will, of action, of valuation, of ideals—lies outside the province of psychology, which is ever busy with the beggarly elements of the mental life and never takes up the problems that interest us as active and moral beings—questions of deeper truth, of beauty, of conscience and religion. The scientific spirit is consequently something which stands in contrast with real life; it is no substitute for the moral and religious spirit.

At the same time Professor Münsterberg somewhat clouds this correct perception of his by putting the antithesis between facts and values too strongly. At times it looks almost as if each could get along without the other; as if a great gulf were fixed between them, so that the realm of ideas appears in almost Platonic isolation from the world of sense-perception. The 'world of values' and the 'world of facts' are of course not two worlds, but rather different ways of considering the self-same world. In Kantian phrase, we might say that facts without values are blind, while values without facts are empty. Professor Münsterberg shows, at least in one passage, that he himself takes this view; but a certain love of contrast and antithesis, too often makes him put the matter otherwise.

And in his endeavor to show the insufficiency of the psychological standpoint, the author really does injustice to psychology. He holds that psychology does, and must 'transform' the facts for purposes of explanation; and explanation, he believes, is possible only when we can restate the facts in terms of atoms or something else equally elementary. In psychology, consequently, everything must, by hook or crook, be analyzed into *sensations*, since these are the mental elements which correspond to the atoms of the physical world. Even when we distinctly know that the real mental process —an idea, an emotion, or act of will—is *not* completely described when we have enumerated the sensations that compose it, nevertheless (according to the author) the psychologist is by the logic of the situation forced to shut his eyes to anything but these sensations and their laws. He must at least make believe that the act of will, for instance, is composed merely of sensations chiefly from the muscles, because only thereby is 'explanation' possible. In psychology, consequently, the truth is inevitably concealed, and some complex of sensations is substituted for the real mental process which we are to explain.

Few psychologists, I feel sure, would admit that this is a correct account of the psychological method. It sounds almost like a veiled *apologia* for some of the theories of both Professor Münsterberg and Professor James. They have each in their own way attempted to convince the world that certain 'complexes of sensations' were the whole truth in an act of will or an emotion; and the world has in the main steadily refused to be convinced. But now we are, as it were, called into the private office, and are told: "Of course, gentlemen, the complexes of sensations really are *not* the will or the emotion, but that is what we have to say they are if we are to be faithful to psychology."

But if in actually experiencing volition or emotion we clearly see that it is not a mere group of sensations, why should we be called upon gravely to declare in our psychologies the opposite? There is nothing in the rules of psychology to prevent our saying all the while that we are talking about the *sensations* characteristic of will or of emotion or of judgment—a mere part of the full process in consciousness. And if we can see, for instance, that a judgment has features additional to the mere sensations of muscular flexion or extension, I see no reason why, as psychologists, we should say, resignedly, that these other features are indescribable and beyond the pale of science. Quite apart from the question of values or of ideals, the experience itself reveals peculiarities of form that are quite definite and intelligible and communicable—has subject and predicate and the affirmative or negative connection, all of which are absent when the same sensations appear in a merely associative or temporal connection. Professor Münsterberg gives no sufficient reason why psychologists should hold that sensations are the only things in a mental process that are definite and describable and capable of helping to explain the process. As well might the physicist say that in his realm the bare atoms are all that he can take account of; when, in fact, time and distance are most necessary for any explanation that really explains. In other words, physical science has to take account both of the 'elements' and of their relationship or 'form.' And psychologists must do the same, noting not only such relations as are common to psychology and the physical sciences (time, for instance), but searching diligently whether there may not be some that are peculiar to our private mental life.

The general trend of the book, as can be readily seen, is to propose a more moderate estimate of psychology in general and of the laboratory work particularly. The later methods all come in for a drubbing: there is no quantitative work possible by psychological experiments; the brain physiologists can only borrow from psychology but give nothing in return; and child-study, with honorable exceptions, is something of a humbug. So that the general tone is a trifle disheartening to any of us who have faith in psychology and wish it well. As a counter-blast to those writings that magnify the office of psychology it may serve a good purpose. And since it is largely addressed to teachers, its chief benefit will undoubtedly be to remind them that a correct appreciation of the child and of the aims and ideals which are to be aroused in him is quite as important as a knowledge of the mechanism of the child's mind.

GEORGE M. STRATTON.

UNIVERSITY OF CALIFORNIA.

The Races of Man. An Outline of Anthropology and Ethnography. By J. DENIKER, SC. D. (Paris)–London. 1900. Walter Scott (American publishers, Charles Scribner's Sons). 611 pp., 176 illus., 2 maps.

The author of this handy text-book, forming Volume 37 in the Contemporary Science Series, is librarian of the Musée d'Histoire Naturelle in Paris. Moreover, he is a ripe specialist in human biology. Having, then, his own past experience as a guide, and being in touch with all the literature upon his theme, one is not surprised to find him interesting and instructive at every point. We may divide the volume into three parts:

Part I. Somatic characters, morphological and physiological, Chapters I.–III.

Part II. Ethnic characters, linguistic, industrial, sociological, Chapters IV.–VIII.

Part III. Classification of races and peoples, general and ethnic, IX. to close.

The first and the third parts are the best written, being in the author's special line. One is always eager to find out the point of view of a work like this, and we are not kept in suspense. 'Ethnic groups' are at once separated from 'somatological units' or 'races.' The latter are "theoretic types formed of an aggregation of physical characters combined in a certain way." These entities, theoretic conceptions, are exactly like species in zoology. Here is Deniker's list:

		RACES AND SUB-RACES.
A. WOOLLY HAIR, BROAD NOSE.		
	Yellow, short, dolicho.	1. *Bushmen* (s. r. Hottentots and Bushmen).
Dark skin.	Reddish-brown, short, sub-brachy, sub-dolicho.	2. *Negrito* (s. r. Negrillo and Negrito).
Dark skin.	Black, tall, dolicho.	3. *Negro* (s. r. Nigritian and Bantu).
Dark skin.	Brown, black, medium height, dolicho.	4. *Melanesian* (s. r. Papuan and Melanesian).
B. CURLY OR WAVY HAIR.		
Dark skin.	Reddish-brown, leptorhine, tall, dolicho.	5. *Ethiopian.*
Dark skin.	Chocolate, brown, platyrhine, medium dolicho.	6. *Australian.*
Dark skin.	Brownish-black, short, dolicho.	7. *Dravidian* (s. r. Platyrhine, leptorhine).
	Tawny white, leptorhine, brachy., nose hooked, etc.	8. *Assyrioid.*
C. WAVY, DARK HAIR, DARK EYES.		
	Brown skin, black hair, nose narrow, tall, dolicho., ellipitical face.	9. *Indo-Afghan.*
Tawny skin, black hair. Tall.	Aquiline nose, dolicho.	10. *Arab or Semite.*
Tawny skin, black hair. Tall.	Straight nose, dolicho., square face.	11. *Berber* (4 subraces).
Tawny skin, black hair. Tall.	Straight nose, meso-, oval face.	12. *Littoral European.*
Tawny skin, black hair.	Short, dolicho.	13. *Ibero-Insular.*
Dull white skin, brown hair.	Short, brachy, round face.	14. *Western European.*
D. FAIR, WAVY OR STRAIGHT HAIR, LIGHT EYES.		
Reddish white	Wavy, reddish, hair, tall, dolicho.	16. *Northern European.*
Reddish white	Flaxen hair, straightish; short, sub-brachy.	17. *Eastern European.*
E. STRAIGHT OR WAVY HAIR, DARK EYES.		
	Brown, hairy; broad concave nose, dolicho.	18. *Ainu.*
Yellow skin, smooth body.	Prominent nose, tall; elliptical face, brachy or meso.	19. *Polynesian.*
Yellow skin, smooth body.	Short, flat nose, high cheek bone, angular form, dolicho.	20. *Indonesian.*
Yellow skin, smooth body.	Short, prominent straight or concave nose; meso- or dolicho.	21. *South American* (s. r. Palaio-American, S. American).
F. STRAIGHT HAIR.		
Warm, yellow skin. nose straight or aquiline	Tall, Meso.	22. *North American* (s. r. Atlantic, Pacific).
Warm, yellow skin. nose straight or aquiline	Short, brachy.	23. *Central American.*
Warm, yellow skin.	Straight nose, tall, brachy, square face.	24. *Patagonian.*
	Brown-yellow, short, dolicho., round, flat face.	25. *Eskimo.*
Yellow-white skin.	Turned up nose, short, brachy.	26. *Lapp.*
Yellow-white skin.	Straight or concave, nose, short, meso-. or dolicho., high cheek bone.	27. *Ugrian* (s. r. Ugrian and Yeniseian).
Yellow-white skin.	Straight nose, medium height, hyper-brachy.	28. *Turkish or Turko-Tartar.*
	Pale yellow, high-cheek bone, Mongol eye, slightly brachy.	29. *Mongol* (s. r. Northern and Southern).

The succeeding table shows these races in their geographic contiguities.

The last chapters deal with the races by continents. Here the reader will find always references to the best special authorities where the author's statements are meagre. It is a pity that the Bureau of American Ethnology could not have read the proof of names for this continent. It is a little difficult for the English reader to detect 'Shahaptian' in 'Chahaptes.' The Trenton gravel controversy is an open question, and Dr. Deniker should have left it so on page 511. He does the cause no good, and his friends, Wilson and Boule, harm in setting them up as a court of last appeal.

O. T. Mason.

Malay Magic: Being an Introduction to the Folk and Popular Religion of the Malay Peninsula. By Walter William Skeat, with preface by Charles Otto Blagdon. London, Macmillan & Co. 1900. Pp. xiv + 686, 7 figs., 28 plates. Price, $6.50.

The folk mind, everywhere, stands in the same relation to truth that a celestial globe occupies with respect to the heavens. Here and there a star is in the right place, but all the rest is fanciful. But truth is exact agreement between what is and what is said, so, notwithstanding folk-lore is fancy, the beliefs are actually held, and we may have the truth about them. No other student within our acquaintance is better equipped for a work of this kind than Mr. Skeat.

Folk-lore, in this volume, is taken to mean the lore of the uncivilized races, containing in the germ, as yet undeveloped, the notions from which religion, law, medicine, philosophy, natural science and social customs are evolved. The operative side of living is excluded, but the regulative thoughts are folk-lore.

The word Malay incidentally includes with the people of that race in the peninsula others of the same blood near by, but the lore of the Chinese and other non-Malayan folk is excluded. The magician is the middle man between Malays and the spirit world. If he knows and reveals, he is *Pawang;* if he heals, he is *Bomor.* All that either does or says is classed by Mr. Skeats under magic. The Malays have had a series of religions, to wit, the aboriginal cult, which is a primitive sort of Brahmanism, with extensive pantheon, Buddhism and Mohammedanism. Now, it is easily comprehended, as Mr. Skeat shows, that these *Pawangs* and *Bomors* have nothing to do with *Imams, Khatibs* and *Bilals* of the mosques. Also, if the reader is familiar with the present cult of the Latin American tribes, or of the Filippinos, he would not be shocked to see a long string of Malay invocations and magical rites performed before Hindu divinities, demons, ghosts and nature spirits, beginning with: "*In the name of God, the Merciful, the Compassionate,*" and ending with: "*There is no god but God, and Mohammed is His prophet.*"

In order to prepare the way for a better comprehension of Malay magic the author devotes the first fifty pages to native cosmogony, anthropogony, animism and notions about souls. Nearly as many pages discuss the world of spirits, the Malay pantheon and its relation to our world, as well as the class of men who act as go between from world to world.

The remainder of the work gives us the story of Malay beliefs and practices concerning fire, air, earth, water, and the life of man, in which the spirit world is involved, together with the description of paraphernalia the recital of formulæ, prayers, sacrifices, lustrations, fastings, divinations and witchcraft involved. Wisely, in the midst of so much jumbling of ethnic creeds and cults, the author abstains from attempts to analyze, and contents himself with recording in the most scrupulous manner the data on which philosophic discussion must be based. Pages 581-672 are devoted to Malay texts.

It would be unkind to point out little errors and omissions, since an enforced absence from England prevented the author from revising the proofs. The illustrations are not so good as those of Dr. Fewkes along the same line published by the Smithsonian Institution.

O. T. Mason.

Plant Structures. A second book of Botany. By John M. Coulter, A.M., Ph.D., Head of Department of Botany, University of Chicago. Twentieth Century Text-Books. D. Appleton & Company. 1900. Pp. x + 348. 12mo, with 289 illustrations.

Several months ago the companion volume to the work now under review appeared, and was noticed in Science (December 8, 1899). That volume was designated as 'a first book of botany,' while this is said to be 'a second book.' The former ('Plant Relations') attempted to treat the subject from an ecological standpoint, and in our opinion the author failed to make it 'a first book'; in the present volume morphology is the dominant subject, and, as if in some doubt himself, the author says in the preface: "It may be, however, that many teachers will prefer to begin with the morphological standpoint as given in this book. Recognizing this fact 'Plant Structures' has been made an independent volume that may precede or follow the other, or may provide a brief course of botanical study in itself." This remarkably flexible purpose has been well carried out by the author. He has made an excellent *first* book of botany, in spite of its title.

The book follows the approved sequence from the simpler to the more complex plants, and the treatment is that which has been developed in the best botanical laboratories. The very helpful 'Suggestions to Teachers,' prepared by Dr. Caldwell to accompany the book, emphasize the practicability of the course here outlined. One feels as he runs over the pages that he is on ground which has been traversed again and again by teachers and pupils, and that all the work outlined *can* be done, because it *has been* done again and again.

We should like to take up the chapters in detail, but that cannot be done in a brief notice. We could ask here and there for a less confusing sequence (*e. g.*, where Slime Moulds and Bacteria are taken up after Toadstools and Puffballs, and Coleochæte in the midst of the Bryophytes), and far less of generalization before the pupil has some facts in hand (*e. g.*, in Chapter III., where the evolution of sex is discussed when he is as yet in total ignorance of the structural facts on which the theory is hung). On the other hand, the author's generalizations in the form of summaries from preceding groups (*e. g.*, Thallophytes, Bryophytes and Pteridophytes), are admirable.

The illustrations are good, and well chosen. Many have a delightful freshness, in sharp contrast to the well-worn cuts so long familiar in similar text-books.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

Observations made at the Blue Hill Meteorological Observatory, Massachusetts, U. S. A., in the Years 1897 and 1898. Under the direction of A. LAWRENCE ROTCH, A.M. With an Appendix containing the *International Cloud Measurements during 1896–97.* Annals of the Astronomical Observatory of Harvard College. Vol. XLII. Part II. 4to. Cambridge, 1900. Pp. 131–280.

The cloud work done at Blue Hill Observatory is known to meteorologists the world over, the publications on clouds already issued by this Observatory having been among the most important contributions to meteorology in recent years. This satisfactory result has been made possible through the liberality of Mr. A. Lawrence Rotch, the founder and director of the Observatory, and through the admirable work done at the Observatory by Mr. H. Helm Clayton and his associates, Messrs. S. P. Fergusson and A. E. Sweetland. Mr. Clayton's *Discussion of the Cloud Observations* made at Blue Hill (Annals Harv. Coll. Obs'y, Vol. XXX., Part IV.), is the most complete publication on clouds ever issued (see SCIENCE, N. S., Vol. V., 1897, pp. 468–469). When the 'International Cloud Year' was begun on May 1, 1896, in accordance with the recommendation of the International Meteorological Committee in 1894, the Blue Hill Observatory was one of the stations in the United States which co-operated in this special work, the other stations being those under the jurisdiction of the Weather Bureau. The present volume includes the usual meteorological observations made during 1897 and 1898, publication of which was delayed in order that an appendix containing a discussion, by Mr. H. H. Clayton, of the *Measurements of Cloud Heights, Velocities and Directions*, carried out during the 'Cloud Year,' might be included. In this Appendix are printed the tables containing details of all the cloud observations made throughout the 'Cloud Year,' together with tables showing the mean heights and mean velocities of the clouds at different hours and seasons; the number of clouds and measurements; the mean, maximum and minimum heights and velocities by months; the mean heights with different temperatures and pressures; the mean heights with different gradients; the mean heights of clouds from different directions; the mean velocities and frequencies of the clouds at different heights; the frequencies of the different currents at different heights, etc. The mere enumeration of the headings of these tables will suffice to show the thoroughness of the work discussed in this volume—a thoroughness which is characteristic of all of Mr. Clayton's cloud studies. The text accompanying the tables discusses the methods of measurement and of computation employed, and the meteorological results of the investigation. It is impossible to present any adequate summary of the important results reached by Mr. Clayton. Those who seek further information should turn to the volume itself, which is worthy of careful study. There is, however, one point which we would notice here. From a series of special measurements of cumulus and fracto-cumulus clouds, made with a view to determining the relation between the heights of these clouds as obtained by theodolites and from the dew-point, it appears that turreted cumulus clouds are most frequent at the coldest time of day, and not at the warmest, as is the case with ordinary cumulus. Thus, as Mr. Clayton points out, it seems that the diurnal period of the turreted cumulus is not determined by heating at the ground but by cooling at the surface of the cloud. The turreted cumulus probably forms only when the decrease of temperature from other causes approaches the adiabatic rate. It is thus an indication of thunderstorms, for a rapid vertical decrease of temperature in the upper air, when combined with a rapid decrease in the lower air caused by heating at the ground, favors the ascent of columns of air from the ground, to great heights and this is a condition favorable to thunderstorms.

The present volume is fully worthy to take its place in the line of Blue Hill Observatory publications as another important American contribution to meteorology.

R. DEC. WARD.

BOOKS RECEIVED.

Text-Book of Paleontology. KARL A. VON ZITTEL. Translated and edited by CHARLES R. EASTMAN. London and New York, The Macmillan Company, 1900. Pp. ix + 706.

Volumetric Analysis. JOHN B. COPPOCK. London, Whittaker & Co.; New York, The Macmillan Company. 1900. Pp. 92.

The Soul of Man. PAUL CARUS. Chicago, The Open Court Publishing Company. 1900. Pp. xviii+482.

The Teaching of Elementary Mathematics. DAVID EUGENE SMITH. New York and London, The Macmillan Company. 1900. Pp. xv + 312.

The Criminal, his Personnel and Environment, a scientific study. AUGUST DRÄHMS, with an Introduction by CESARE LOMBROSO. New York and London, The Macmillan Company. 1900. Pp. xiv+40.

SOCIETIES AND ACADEMIES.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

AT the 514th meeting of the Society, held at the Cosmos Club on March 3d, Professor C. Abbe read an obituary notice of Professor H. A. Hazen. Dr. L. A. Bauer, then gave a detailed statement of the methods to be pursued in carrying out the magnetic survey of the United States by the Division of Terrestial Magnetism of the U. S. Coast and Geodetic Survey.

As an indication of the scope and character of the data to be derived from the detailed magnetic survey of the United States, a brief statement was given regarding the results obtained from the detailed magnetic surveys of Maryland and of North Carolina. Furthermore there were exhibited various charts giving a graphical analysis of the earth's magnetic field for various portions of the United States.

With the aid of these charts, it was shown very clearly how inadequate it is for the formation of theories of the earth's magnetism to have simply declination data alone.

Following Dr. Bauer's paper, Dr. Alexander Macfarlane of Lehigh University, discussed the 'Square Root of minus one.' He reviewed the explanations published by Payfair, Buée, Argaud, Français, Gauss, Cauchy, Boole, Hamilton, Cayley and other mathematicians and concluded that $\sqrt{-1}$ does not indicate direction nor rotation of the quantity to which it is attached, nor a turning of the plane of representation, nor a special unit; that + and — are not signs of addition and subtraction but are signs of affection, and so is $\sqrt{-1}$. He gave analytical expressions for these signs, which show their connection with π and applied them to explain the rule of signs, the roots of + and —, the logarithm of quantities, the fundamental rules of quaternions and vector-analysis, the analogy of the circle to the hyperbola, and imaginary intersections.

E. D. PRESTON,
Secretary.

THE TEXAS ACADEMY OF SCIENCE.

THE regular monthly meeting of the Texas Academy of Science was held in the Chemical lecture room of the University of Texas on Friday evening, February 16th, President Simonds in the chair.

Dr. H. Y. Benedict, Instructor in Mathematics and Astronomy in the University, spoke on 'Astronomy in the XIX. Century' which took the form of a summary of achievements in that branch of science during the past hundred years. First he considered the additions to instruments, the invention of which had materially assisted in the refinement and increase of our knowledge, special mention being made of the spectroscope, camera, photometer, etc.

Additions to the solar system constituted the next topic. These were both numerous and important, including one planet—Neptune—its satellite, the two satellites of Mars, the fifth of Jupiter, Hyperion and the ninth of Saturn, and the two of Uranus.

The cometary and periodic movements of meteorites were mentioned as were also the measurements of the parallaxes of the fixed stars.

The last topic, the 'Nebular Hypothesis and the Theory of Tidal Evolution,' aroused considerable enthusiasm. Among those who took part in the discussion were Professors Halsted, Harper, Ellis and Mezes. Throughout the paper it was made plain that in the astronomical work of the century Americans had played a leading part.

Dr. L. E. Dickson, Associate Professor of Mathematics, presented a paper entitled 'An Elementary Account of the Greater Problems solved by the Modern Group Theory.' Among the examples chosen to illustrate the definition of a group, the most elementary was that of the three distinct rotations of a plane triangle into itself, viz, the right-hand and the left-hand rotations through 120° and the zero-rotation called the identity. Denoting them by R, L, I, respectively, it is seen by inspection that

$$R^2 = L, \quad L^2 = R, \quad RL = LR = R^3 = L^3 = I,$$

so that the result of applying any one of the three and afterwards any one of the three is equivalent to applying some single one of the three. The corresponding permutations of the three vertices give rise to a 'group of substitutions.'

The connection between rational, integral functions and groups of substitutions was illustrated by several examples. The solution of the quadratic and cubic equations was made to depend upon the determination of very simple non-symmetric functions of their roots. After indicating the impossibility of solving by radicals the general equation of degree $n > 4$, the question of the solution of special equations was declared to be a problem capable of most direct answer by employing the group of the equation, as developed by Galois. A problem in mathematics usually depends upon the solution of an algebraic equation or upon the integration of a differential equation. By considering the group of the equation, finite in the former case and continuous in the latter, we are able to decide whether or not the equation can be solved by radicals or integrated by quadratures. More generally it tells what series of simple problems may be taken in place of the original problem. The group of a problem not capable of such a reduction to a chain of simpler problems is called simple. To borrow a chemical term, these simple groups are the 'elements,' to which any problem in its final analysis is to be reduced. The present state of our knowledge of these elements was discussed both for finite groups and for continuous groups.

Professor Thos. U. Taylor, M.C.E., read an abstract of his report to the U. S. Geological Survey on 'The Silting up of Lake McDonald, Austin, Texas.' This is the body of water retarded by the erection of the great dam across the Colorado River. A comparison of the cross-sections of the lake at sixteen different stations, averaging $1\frac{1}{4}$ miles apart, for 1893 and 1900, shows that the lake had silted up 48 per cent. of its original storage capacity; that when reduced to a square mile base there was in 1893 a storage capacity of 81 feet in depth, but in 1900 only 42 feet. This result, reached in the space of 6⅞ years, gives an average of 5.8 feet of silt per year on the mile base. According to the laws of silting the deposit was for the first year 7.5 feet, for the second year 6.9 feet, for the third year 6.2 feet, etc. The silt in the upper two miles of the lake is mostly sand, while that of the lower two-thirds is composed of a fine, impalpable, absolutely gritless deposit. The Colorado River flows through a hilly country for hundreds of miles, and is not a heavy silt-bearing stream except on the Red Fork.

F. W. S.

University of Texas.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of March 5, 1900, forty-two persons present, the following subjects were presented:

'An Annotated Catalogue of the Muricidae,' by Mr. F. C. Baker, was presented by title.

A paper by Professor A. S. Hitchcock, entitled 'Studies on Subterranean Organs.' II. 'Some Dicotyledonous Herbaceous Plants of Manhattan, Kansas,' was presented in abstract and illustrated by specimens.

Mr. J. S. Thurman addressed the Academy on 'Liquid Air,' tracing the history of the liquefaction of gases and in particular the success reached in liquefying air since this result was first achieved in 1877 by Pictet and Cailletet. The possibilities of the utilization of liquid air as a motive power and an explosive, and its employment in medicine and as a disinfectant, were passed in analytic review by the speaker, whose conclusions were that there seemed no present probability of its useful application either as a disinfectant or a motive power. In medicine and for certain purposes requiring the use of explosives it was stated to be not impossible that it would ultimately find useful application, although its prospects as an explosive did not seem very promising.

Four persons were elected active members of the Academy.

William Trelease,
Recording Secretary.

ANTI-PLAGUE INOCULATION.

The Indian Plague Commission have made public through the India office part of their report, including the following paragraphs in regard to anti-plague inoculation:

With regard to the feasibility of adopting a general policy of inoculation, our conclusion may be set forth as follows:

(1) Experience gained hitherto has shown that it is very seldom possible to get a large proportion of the inhabitants of an uninfected place inoculated.

(2) It has been possible, where the inducement of exemption from segregation and eviction has been offered, to get a large proportion of the inhabitants of an infected place inoculated quickly.

(3) It has been possible in one place—Mysore City—even where no inducement that touched the great mass of the people could be offered, to get a considerable proportion of the inhabitants of an infected place inoculated quickly.

(4) It has been possible also to induce a large proportion of particular communities, such as the Khojas of Bombay and Karachi, to be inoculated under the influence of their leaders.

Our recommendations are governed by those conclusions, as well as by the conclusions we have already drawn with regard to the protection conferred by inoculation. They are further governed by the consideration that it is necessary, as far as may be possible, to dispel the particular objections on account of which the people have hitherto refrained from inoculation. Moreover, our recommendations are based on the consideration that it is advisable to make the operation as effective as possible, as little inconvenient as possible to the person inoculated, and as easily carried out as possible by the inoculator.

I. We have already insisted on the necessity for the accurate standardization of the vaccine, as being essential to the attainment of the best results, both as to the protection conferred and as to the duration of that protection. We have pointed out, also, that the introduction of an accurate system of standardization may possibly obviate the necessity of employing two successive inoculations.

II. With a view to dispelling the natural fears of the people and avoiding all unnecessary risk to the inoculated, and, further, with a view to enabling the inoculations to be carried on with the least possible amount of attendant inconvenience, we would insist upon the necessity that stringent precautions should be taken to insure that all the vaccine used is quite free from contamination, and we would recommend that the volume of the necessary dose should be made as small as possible.

III. With a view to removing any possible ground for distrust as to the conveyance of disease by inoculation from one person to another we would recommend that the syringe should be sterilized in the presence of the person about to be inoculated.

IV. We are of the opinion that inoculations, under the safeguards and conditions stated above, should be encouraged wherever possible, and, in particular, it seems to us desirable to encourage inoculation among disinfecting staffs and the attendants of plague hospitals.

We cannot bring to a conclusion this consideration of anti-plague inoculation by Mr. Haffkine's prophylactic fluid without expressing our sense of the importance of the method which Mr. Haffkine has devised and of the results which have been achieved by it. The credit due to Mr. Haffkine is the greater because the difficulties with which he had to contend in this matter could only have been overcome by great zeal and endurance. Mr. Haffkine's work on anti-plague inoculation, while not based on any new scientific principle, constitutes, it seems to us, a great practical achievement in the region of preventive medicine.

SPIRIT-LORE OF THE MICRONESIANS.

RECENTLY the director of the ethnographic division of the royal museums at Berlin has returned from a prolonged visit to the Sunda islands, Micronesia and Melanesia, and is now able to give to the world the multifarious results of his observations and researches. Micronesia had heretofore been studied in part only, as far as its ethnography is concerned, and it was chiefly the Pelew islands that had attracted a share of attention from German scientists; although the Mariana islands had been considered also. Research has now been made much easier by the number of colonies which Germany has established in this insular domain.

The entire group of the Carolinian islands, with a native population of about 30,000, is what Director Adolph Bastian chiefly describes in his recent publication, 'Die mikronesischen Colonien aus ethnologischen Gesichtspüncten,' Berlin, 1899. Octavo, pp. 7 and 370. To begin with, Dr. Bastian gives a sketch of the social life of the Pelew nation, of their chiefs, notables and government. Then follow his observations on mortuary rites, their theories about death, the soul after death and the mutual intercourse of souls. Then are discussed Malay theories of black and white magic (whatsoever this may be), of demonology, the tutelary genii, the creation of the world, evolution and what we call the infinite. The demonology is among the Malays weird and fantastic, as might be expected, but also highly poetical and full of originality. For many years back the white race has been informed of the religious views and mythology of the Maori, the Samoa, Tonga and Mangaia islanders, and there is no denial of the fact that the cosmogony and spirit-worlds of these natives are as grand in their conception as those of many peoples of European antiquity. Their systems of the world and of after-life come very near the metaphysical, and when the European who transmits these views to us is himself a philosopher, or at least a thinker, he will make the Malay systems appear to us so much the more philosophical. Dr. Bastian, being a votary of the comparative method in ethnology, has for every myth, custom or belief a score of parallels ready, which he takes from Mediterranean, African, American or any other tribes or nations of the globe, or historic comparisons of beliefs from Greece, Rome, Mesopotamia, China, or Mexico. Anyone able to follow Bastian in his vast amount of reading (his quotations of sources are *summary* and therefore of little use), will undoubtedly derive benefit from what he states. But these statements are given in a manner that is too chaotic and profuse and most readers find it too difficult to follow the thread of his argumentation.

Oracles through whistling are found throughout these islands. Their main gods transmit their behests to men through ghosts or dead children by whistling sounds or whispered words. Tattooing is permitted only when a deity has given his assent by whistling; house spirits and the genii of trees give their revelations by whispers only. A. S. G.

APPLIED THERMODYNAMICS.

IN a recent publication of '*Documents sur la Laboratoire de Mécanique de l' Université de Liége,*' describing its methods of instruction, by the Professor of Applied Mechanics and of Industrial Physics, M. Dwelshauvers-Dery, we find a *resumé* of researches in applied thermodynamics, mainly in the experimental study of the steam-engine, which is interesting as exhibiting the character and extent of the work recently performed, and valuable as supplying important data previously unknown.

This laboratory of applied mechanics was completed in 1893, after, as the author of these documents says, five years of constant solicitation of the government to supply this '*auxiliaire précieux,*' of which M. Dwelshauvers-Dery was the first to conceive the idea, a generation ago, though so late in its realization. His idea was that of a laboratory of research and instruction in engineering, to be employed in the work of the regular courses leading to technical degrees and devoted to the purposes of the student, rather than, as previously usual in nearly all departments of applied science, primarily for those of the distinguished professor in charge and only secondarily and incidentally for the student.

The researches which have been conducted since the date of completion of this laboratory by the Director, assisted by his staff and by advanced and able students, have been mainly in applied thermodynamics. M. Dwelshauvers-Dery is a disciple of Hirn and aided in the investigations made in Alsace at the beginning of the work of his eminent leader. Since that time, the famous discussion between Zeuner and Hirn and their followers has made this work and these workers familiar to all investigators and students in that field. It has been in the supplementing of Hirn's earlier work that the experimental steam-'plant' at Liége has been mainly occupied recently.

Among other investigations, those relating to the influence of the water collecting in the steam-chest of the engine upon its efficiency, on the effect of superheating, on the use of the steam-jacket, on the effect in the real engine of compression, and those on the condition of the vapor, as to 'quality,' in the clearance spaces, have been the most extensive and important.

It was found to be the unquestionable fact that, with the engine employed, it was advantageous to continually drain the water of condensation from the valve-chest of the engine when using moist steam and whether the jacket is in use or not. With superheated steam, naturally, no effect was observed.

The steam-jacket was found to give an economy of from 24 to 28 per cent., either with or without superheating; the latter being a disputed question until thus, for this case, at least, settled. Superheating produced an economy of about 20 per cent., as a maximum.

The investigations of the quality of the vapor in the compression period occupied several years and attracted much attention and some opposition to the conclusions reached was manifested by a number of distinguished experts in that department. Those experiments which were made with 'constant absolute work' showed a decided loss by compression and a loss proportional to the amount of the compression; which fact was attributed to the heat-exchanges between vapor and cylinder-wall. This conclusion was challenged and it was denied that the fundamental assumption that, as asserted by Hirn, the steam at the end of emission is dry, could be accepted as true. Dwelshauvers-Dery and his former assistant and pupil, Duchesne, furnished proof of the correctness of his proposition. (Revue de Mécanique, Jan., 1899; July, 1899.)

Mr. Isherwood, the famous pioneer in this class of work and the Engineer-in-chief of the navy during our civil war, suggested that the experiments be repeated, making the 'indicated work' a constant quantity. He thought it possible that it might be found that the use of compression was neither economical nor wasteful in the actual case and, therefore, its use simply a question of smoothness of operation of the machine and entirely outside the realm of applied thermodynamics. The work of the past year has been in this line of investigation and the results have sustained the view of Commodore Isherwood.

The schedule of proposed work for the year 1900 includes the study of the effect of 'throttling' steam, as proposed by Isherwood.

The publication of these documents for the use of the Congress of Applied Mechanics at the coming International Exposition at Paris gives all interested in this department of research and in this kind of instruction an opportunity to learn just what are the methods employed, the apparatus used and the character of the researches best adapted for laboratory work of this sort in the instruction of the young engineer and physicist, as arranged by a pioneer in this field.* The work reported has been extensive, important and admirable in method and in its execution. It has been conducted under circumstances of very great difficulty, patiently, carefully, persistently, and while few who have not kept in touch with it while in progress can realize what labor and sacrifice have been involved, every specialist in this department will recognize its value and elegance.

R. H. THURSTON.

* Documents sur le Laboratoire de Mécanique de l'Université de Liége, et sur l'Enseignement qui y est donné par V. Dwelshauvers-Dery, Professeur de mécanique appliquée et de physique industrielle. Liége, Charles Desocr, Editeur, 1900.

A NEGLECTED DEPARTMENT.

THE American Society of Mechanical Engineers is issuing to its members a circular, prepared by its Council, calling attention to the neglect of the Patent Office of the United States by Congress, to its importance to the country and to its hoppled condition as produced by the refusal of Congress to provide for either suitable accommodations or a sufficient clerical force and staff of examiners. Members of the Society are urged to force upon the attention of their members of Congress the necessity of "providing sufficient room, force and facilities for the prompt and proper execution of its work," that arrangements be made at once for "providing incombustible receptacles for the records," which records "largely constitute the legal evidence of title of so many of the larger industries of the country," that the library be kept up and properly cared for, that the Patent Office be given the entire control and use of its own building—now occupied largely by 'squatters' from other bureaux—and that its earnings be dedicated to its own purposes and improvement. The Patent Office is 'out of practical politics,' and is only prevented from doing its full duty to the country by its lack of space and of force. Yet, up to January 1, 1899, 693,979 patents had been granted, and 41,422 trade-marks registered. Last year alone 25,527 patents and 2260 trade-marks were added to the record. The accumulations of records and of exhibits has come to be so great as to put it quite beyond the power of the restricted force in its restricted space to properly store, arrange, classify and care for them. The library, which it is imperatively necessary to keep up to the highest state of efficiency, and which should be a complete collection of the technical publications of the world, and of all time, was last year only allowed $1500 for purchases of books. No funds at all were obtainable for the law library. The whole business of this department of government, upon which the success of our great industries is so absolutely dependent is trammelled, and every industry of the country is embarrassed, by its forced inefficiency. This inefficiency is entirely due to the indifference of Congress. The Patent Office has accumulated out of its own earnings a large amount of available capital—several millions of dollars—and it has not been even allowed to draw upon its own funds to meet imperative needs.

So indifferent, in fact, have been some Congresses that it is within the experience of the writer that important matters of business, involving large interests, have been delayed for weeks through the impracticability of securing a full meeting of a committee, repeatedly called.

R. H. THURSTON.

MUSEUM OF THE STATE OF NEW YORK.

DURING the winter season, the energy of the museum staff has been concentrated on an important series of publications. A bulletin on the clay industries of the State will soon be issued, being a second edition of one prepared in 1893. A report on the lime and cement of the State is nearly ready for the printer. Work is also rapidly progressing on the new edition of the geologic map of the State on the scale of five miles to the inch.

A new edition of the Economic and Geologic map published in 1894 is almost ready for the engraver. It is on a slightly enlarged scale and will contain a large amount of additional information. A relief model of Niagara River and the vicinity of the Falls on the scale of 1000 feet to the inch is being prepared by Mr. Edwin E. Howell, of Washington, D. C., for exhibition at the Pan-American exposition in Buffalo.

The sixteenth annual report of the State geologist being the report of work done during the incumbency of the late Professor James Hall, has been issued. It contains a number of papers of importance, among them,

'Report on the boundary between the Potsdam and Pre-Cambrian rocks north of the Adirondacks,' by H. P. Cushing.

'The Naples fauna in western New York,' by John M. Clarke.

'The brine springs and salt wells in the State of New York and the geology of the salt district,' by D. D. Luther.

'The faunas of the Hamilton group of Eighteen-mile creek and vicinity,' by A. W. Grabau.

The department has received from Professor C. E. Beecher, of Yale University, a natural size restoration of the immense crablike crustacean *Stylonurus excelsior*, the largest invertebrate animal that has been found in the rocks of New York. It attained a length of about five feet, and its remains were found in the Catskill rocks of Delaware county.

Dr. J. M. Clarke lectured on the 24th ult. in the Columbia University series on the 'Geological History of Parasitism' and will repeat the lecture before the Rochester Academy of Science.

A bulletin on early and recent sites of the Indian tribes of the State, illustrated by two maps, will soon be received from the printer.

In zoology, the biological survey has been continued and volunteers have been organized to observe and report on the birds of New York. This is in continuance of the biological work originally begun under the natural history survey which led to the publication of the reports on zoology and botany in 1824, and which, though for some time suspended for lack of funds, was revived two years ago in the study and collection of fishes of Long Island by Dr. Tarleton H. Bean, and the preparation of a bulletin on the Mammals of New York, together with a key to their identification, now in press.

CURRENT NOTES ON METEOROLOGY.

THE RELATIVE HUMIDITY OF OUR HOUSES IN WINTER.

'The Relative Humidity of our Houses in Winter' is the subject of a paper by R. De C. Ward in the *Boston Medical and Surgical Journal* for March 1st. Observations were made by means of an ordinary sling psychrometer in a furnace-heated room during three weeks of last November. The mean relative humidity in the room for the whole period was 30%, while the mean relative humidity outdoors during the same period was 71%. The minimum relative humidity observed for any whole day was 24% and the maximum for a whole day was 40%. For purposes of comparison, the relative humidities of several stations in arid regions are given in the paper. For instance, the lowest mean annual relative humidity in the United States is that for Yuma, Ariz., which has 42.9%, and a mean monthly minimum of 34.7% in June. Sante Fé, N. Mex., has a mean annual of 44.8%, with a mean monthly minimum of 28.7% in June. Death Valley, Calif., was found to have a mean relative humidity of 23% during five months (May–September) of the year 1891, when a temporary meteorological station was maintained there by the Weather Bureau. Southwestern Siberia and Western Turkestan have a mean of 45–50% in July. Ghadames, in Tripoli, has 27% in July. In India, Lahore has 31% and Agra 36% in May. It thus appears that the air of the room in which the observations were made was drier than that of many desert regions.

DRUNKENNESS AND THE WEATHER.

Science for August 11th last contained an interesting paper by Dr. E. G. Dexter, entitled 'The Mental Effects of the Weather' in which the relations between certain weather elements and the occurrence of certain misdemeanors in New York City were discussed. In *Nature* for February 15th, Dr. Dexter returns to this subject in a communication which is supplementary to the article just referred to. In this note the writer refers to the results of a study made by him to determine the relation between temperature conditions and drunkenness in New York City. The number of arrests (males) for drunkenness for each day during the three years, 1893–1895, was taken from the records of the New York police force. The mean temperature, pressure, humidity and wind movement for each of these days were obtained from the records of the Weather Bureau in New York City. The curve showing the number of arrests for drunkenness plotted with reference to the twelve months of the year shows that the prevalence of intoxication during the cold months is much in excess of that for the warm ones. The curve of arrests for drunkenness plotted with reference to mean temperatures also shows, as a whole, a decrease in the number of cases of intoxication with increasing temperature.

INTERNATIONAL METEOROLOGICAL CONGRESS.

AN International Congress of Meteorology is to be held at Paris from September 10th to 16th of the present year. The President of the *Commission d'Organisation* of the Congress is M. Mascart, Director of the Central Meteorological Bureau of France. The Secretary is M. Angot. Membership in the Congress may be had on payment of 20 francs. The preliminary program includes a long list of subjects in meteorology proper, as well as in oceanography, and terrestrial magnetism and electricity.

RETIREMENT OF MR. R. H. SCOTT.

IT has already been announced in this JOURNAL that Mr. R. H. Scott, F.R.S., was to retire from the post of Secretary to the Meteorological Council of the Royal Society on February 28th. At the end of the year 1899, Mr. Scott had completed 33 years of service in the Meteorological Office, and for the last 25 years he has acted as Secretary of the International Meteorological Committee. Mr. Scott is to be succeeded by Mr. W. N. Shaw, P.R.S., Fellow of Emmanuel College, Cambridge, and up to this time Assistant Director of the Cavendish Laboratory, and Lecturer in Physics in the University of Cambridge.

R. DEC. WARD.

HARVARD UNIVERSITY.

SCIENTIFIC NOTES AND NEWS.

PROFESSOR P. TACCHINI has resigned the directorship of the Royal Italian Bureau of Meteorology and Geodesy after forty years of service. Professor Luigi Palazzo has been appointed temporary director.

THE Royal Academy of Turin has elected Dr. Charles S. Minot a corresponding member.

PROFESSOR MITAG-LEFFLER of Stockholm, has been elected a corresponding member of the Paris Academy of Sciences in the Section of geometry.

GLASGOW UNIVERSITY has offered the degree of LL.D., *honoris causa*, to Mr. A. Smith Woodward, the vertebrate paleontologist of the British Museum.

THE University of Aberdeen will confer the degree of LL.D. on Mr. W. R. Sorley, professor of moral philosophy in the University of Aberdeen.

MR. DEAN C. WORCESTER, whose appointment as a member of the new Philippine Commission we announced last week, has resigned the assistant professorship of zoology in the University of Michigan. It is reported that Mr. Worcester has been offered a salary of $15,000 a year as manager of certain mining interests in the Philippine Islands and that when his duties as commissioner are fulfilled he may accept the offer. His salary at the University of Michigan was $1600.

PROFESSOR PERRY G. HOLDEN has resigned the chair of agriculture in the University of Illinois to become manager of the agricultural department of the Illinois Sugar Refining Company.

Mr. W. A. Taylor, assistant chief of the division of pomology, department of agriculture, has sailed from New York to take charge of the United States exhibit of fruits at the Paris Exposition.

THE Rumford medal, which, as we announced sometime since, was awarded by the American Academy of Arts and Sciences to Mr. Charles F. Brush, was presented to him at a meeting held last week in Boston. Professor Charles R. Cross, of the Massachusetts Institute of Technology, Chairman of the Rumford Committee, made a brief address, describing the grounds for the award and the arc lamp invented by Mr. Brush; Professor Trowbridge presented the medal and Mr. Brush made a reply. Professor Elihu Thomson read a paper describing a new method of producing an electric current of high voltage.

COLUMBIA UNIVERSITY has been given a statuette of Professor Charles Hackley, who held the chair of mathematics and astronomy in Columbia College from 1843–1861.

WE regret to record the death at her home in New York city, of Miss Catherine Wolfe Bruce, who made generous gifts for the advancement of astronomy to Harvard University, Columbia University and other institutions.

M. EMMANUEL LIAIS, Mayor of Cherbourg, has died at the age of seventy-four. For many years he held posts at the Paris Observatory, and he was sent in 1857 to South America to watch the solar eclipse. He organized telegraphic meteorology in France, and devised the use of chronographs in determining longitude by electricity. He bequeaths his property to the municipality of Cherbourg in trust for scientific purposes.

DR. WILLIAM MARCET, F.R.S., died at Luxor, Egypt, on March 4th, in his seventy-second year. He had been president of the Royal Meteorological Society, and was the author of books on health resorts and on the history of the respiration of man.

DR. F. JAGOR, known for his scientific expeditions, died at Berlin on February 11th, at the age of 83 years.

DR. CARL MARIA PAUL, geologist of the Austrian bureau, died at Vienna on February 10th.

MR. JAMES G. SMITH, one of the inventors of the duplex system of telegraphy, died in New York City, on March 13th.

THE Fish Commission steamer *Albatross* has arrived at Yokohama. After refitting, the vessel will proceed to Alaska for the purpose of continuing the investigations in the salmon streams begun some years ago.

AN expedition consisting of Professor E. B. Poulton and Mr. E. S. Goodrich, from Oxford University, and Messrs Oldfield Thomas and R. I. Pocock, from the British Museum, is just starting for the Balearic Isles to make zoological collections. Although within easy reach, these islands are still little known to naturalists, so that the collections, if containing no novelties, will be of much service in completing the faunal series of the London and Oxford Museums.

MRS. PHOEBE HEARST has undertaken to defray the expenses of explorations and excavations in various parts of the world, to secure collections for the archæological museum to be established at the University of California. Dr. George A. Resinel is expected to have charge of the work in Egypt; Dr. Alfred Emerson in Greece and in Etruria; Dr. Euler in South America and Yucatan, and Dr. P. M. Jones in California and Mexico.

DR. J. W. GREGORY, the new professor of geology at Melbourne, has been appointed director of the scientific staff on the British Antarctic Expedition, which, as at present arranged, is to start in August, 1901. It is to be hoped that Dr. Gregory's recent severance from the British Museum will not prevent the natural history collections coming to that establishment as was originally intended. Another scientific man who thinks of taking a trip to the Antarctic is Dr. Otto Nordenskiöld.

THERE will be a Civil Service Examination, on April 17th, to fill the position of Field Assistant in the Division of Forestry, Department of Agriculture, at a salary of $1000 per annum.

BELGIUM has established a botanical garden and experiment station at Coquilhatville in the Congo Free State.

A BRANCH of the American Chemical Society has been established for the State of Michigan, with its headquarters at the University of Michigan. The first officers are: *Presiding Officer*, Professor A. B. Prescott; *Secretary*, Alfred H. White; *Councillor*, Professor Paul C. Freer—all of the University of Michigan. The members of the executive committee are: A. F. Shattuck, chemist to the Solvay Process Company, Detroit; Professor F. S. Kedzie of the Agricultural College, and J. V. Wolfe, Jr., chemist to the Detroit Sugar Company at Rochester.

THE New York *Evening Post* reports that a contract to slaughter 20,000 birds of all sorts near Milford, Delaware, for the benefit of a millinery firm in New York, has aroused a storm of indignation. Fully a dozen societies, headed by the Academy of Natural Science have taken action to prevent the killing of the birds. A notice denouncing the proposed slaughter has been sent out by Mr. Witmer Stone, Chairman of the American Ornithologists' Commmittee on Bird Protection. The committee will prosecute wherever the law is violated.

THE *Scientific American* states that the Geographical Society of Philadelphia is to continue its work of setting wooden casks adrift on the ice north of this continent, to demonstrate the currents of Arctic waters north of Behring Strait. Each cask will contain a blank to be filled in by the finder.

READERS of this JOURNAL have doubtless noticed in the daily papers the announcement of the excommunication of Dr. George St. Mivart from the Roman Catholic Church, because he would not revoke articles contributed by him to the *Fortnightly Review* and the *Nineteenth Century*. The formula sent by Cardinal Vaughan to Dr. Mivart for his signature has been published in the London *Times* and is herewith in part reproduced as an explicit statement of what must be believed by communicants in the Roman Catholic Church:

I therefore firmly believe and profess that the Blessed Virgin Mary conceived and brought forth the Son of God in an ineffable manner by the operation of the Holy Ghost, and absolutely without loss or detriment to her Virginity, and that she is really and in truth, as the Catholic Church most rightly calls her, the 'Ever Virgin'; that is to say, Virgin before the birth of Christ, Virgin in that birth, and Virgin after it, her sacred and spotless Virginity being perpetually preserved from the beginning, then, and for ever afterwards. * * * I firmly believe and profess in accordance with the Holy Council of Trent that the first man Adam, when he transgressed the command of God in Paradise, immediately lost the holiness and justice in which he had been constituted, and that he incurred through that prevarication the wrath and indignation of God, and that this prevarication of Adam injured, not himself alone, but his posterity, and that by it the holiness and justice received from God were lost by him, not for himself alone, but for us all. * * * I reject as false and heretical the assertion that it is possible at some time, according to the progress of science, to give to doctrines propounded by the Church a sense different from that which the Church has understood and understands, and consequently that the sense and meaning of her doctrines can ever be in the course of time practically explained away or reversed.

WE learn from *Nature* that the Reale Institute Lombardo has awarded its prizes as follows: The 'ordinary' prize offered by the Institution for the best catalogue of remarkable meteorological phenomena prior to 1800 was unawarded, but premiums of 400 lire have been awarded to three of the competitors, and the judges consider that the publication of the results arrived at conjointly by the three would be of great value. Under the Cagnola foundation five prizes were offered, and none awarded, the only award being a premium of 1000 lire to the sole competitor who sent in an essay on illustrations of Hertz's phenomena. On two of the other subjects no essays were sent in, and on the other two the essays were not of sufficient merit to justify an award. The Pizzamiglio prize and the Ciani prize, for essays in political science, and the Zanetti prize, for discoveries in pharmaceutical chemistry, are all unawarded. The Fossati prize, for an essay illustrative of the macro- and micro-scopic anatomy of the central nervous system, has been conferred on Dr. Emilio Veratti. In striking contrast to the paucity of competitors in subjects of a more or less academical character is the keen competition for the Brambilla prize, given "to one who has invented or introduced into Lombardy some machine or some industrial process from which the population may derive a real and proved benefit." Seventeen competitors entered for this prize, the awards including a gold medal and 500 lire each to Bianchi and Dubini, for desiccators of silk-cocoons; to

Aurelio Masera, for new processes connected with the textile industry; and to M. Rusconi, for developing the 'Mercer' process in the cotton industry. In addition, gold medals and 400 lire are awarded to Carlo Carloni, for his invention of a mastic called magnesite, as a substitute for red lead for junctions of pipes, also for a bicycle brake; to Demetrio Prada and Co., for extracts used in tanning and for the manufacture of oxygenated water; and to J. Löffler, for introducing into Milan the manufacture of artificial flowers in porcelain. A gold medal and 300 lire is awarded to the Italian Color Manufactory under Max Meyer & Co., and a bonus of 300 lire to E. Tuffanelli, of Milan, for an invention connected with water and gas pipes.

At the Royal Institution on March 2d, Major Ronald Ross delivered a lecture on 'Malaria and Mosquitoes.' According to the London *Times*, he first alluded to the discovery of the parasite of malaria by Laveran in 1880, and the failure of the subsequent attempts to find the parasites in the water and soil of malarious places. He described the theories of King, Laveran, Manson and Bignami that mosquitoes conveyed the disease, and said that it was Manson's theory alone which led to the solution of the problem. Believing that it was the only one of practical value, he undertook to verify Manson's theory, and began work in India in 1895. The task presented many difficulties, but after two and a-half years of failure he at last found the parasites growing in mosquitoes belonging to the genus called *Anopheles*. That was in August, 1897. The following year he completely traced the development of the malaria parasite of birds in the mosquito, and finally, in June, 1898, he succeeded in infecting a number of healthy birds with malaria by the bites of mosquitoes. His investigations had proved that not only the infection itself but the severity of it could be transmitted through the mosquito. Out of 28 healthy sparrows which were used, he succeeded in infecting 22, although he failed to transmit the infection from sparrows to several other kinds of birds. In December, 1898, his investigations were repeated and confirmed by Professor Koch and Professor Grassi, and Drs. Bignami and Bastianelli, who also succeeded in infecting healthy men by the bites of mosquitoes in Italy. The investigations had undergone great development since then. The mosquito theory explained all the facts about malaria.

UNIVERSITY AND EDUCATIONAL NEWS.

AN ASSOCIATION OF AMERICAN UNIVERSITIES.

The Chicago *University Record* gives an account of the meeting of representatives of certain institutions held at the University of Chicago, February 27th and 28th. The invitation to this meeting was made by the Presidents of Harvard University, Columbia University, Johns Hopkins University, the University of Chicago, and the University of California. There were present representatives of the University of California, the Catholic University of America, the University of Chicago, Clark University, Columbia University, Harvard University, Johns Hopkins University, Leland Stanford Jr. University, the University of Michigan, the University of Pennsylvania, Princeton University, the Federation of Graduate Clubs, and the United States Commissioner of Education.

After a full discussion, it was unanimously voted that the universities represented in the conference organize themselves into an association. A committee was appointed, consisting of President Jordan, President Harper, Professor Pettie, President Conaty, and Professor Newbold, to prepare the constitution of the association. At an adjourned meeting the following articles were adopted:

CONSTITUTION.

This organization is called the Association of American Universities.

It is founded for the purpose of considering matters of common interest relating to graduate study.

It is composed of institutions on the North American Continent engaged in giving advanced or graduate instruction.

Its initial membership consists of the following institutions:

University of California.	Clark University.
University of Chicago.	Cornell University.
Columbia University.	Johns Hopkins University.
Harvard University.	
University of Michigan.	Princeton University.

University of Pennsylvania.	Leland Stanford Jr. University.
University of Wisconsin.	Yale University.
Catholic University of America.	

Other institutions may be admitted, at the annual conference, on the invitation of the Executive Committee, endorsed by a three-fourths vote of the members of the Association.

The Association shall hold an annual conference at such time and place as the Executive Committee may direct.

The Executive Committee shall prepare a program for each meeting.

The officers of the Association shall be: President, Vice-President, and Secretary. These three, with two others elected by the Association, shall constitute the Executive Committee.

In each conference each university may have any number of representatives, but each university shall have a single vote.

No act of the Association shall be held to control the policy or line of action of any institution belonging to it.

After the adoption of this constitution, the following officers were elected for the ensuing year:

For the President of the Association—the Representative of Harvard University.

For the Vice-President—the Representative of the University of California.

For the Secretary—the Representative of the University of Chicago.

For the additional members of the Executive Committee—the Representatives of Columbia University and Johns Hopkins University.

At a meeting of the Executive Committee the Secretary was authorized to communicate with each of the institutions concerned, and to secure, if possible, the formal acceptance by each institution of membership in the Association.

It was decided by the Executive Committee to hold the next annual meeting during the last week of February in the city of Chicago. It was also voted that the meeting should not include more than four sessions, and that each university should be asked to suggest topics for discussion. The following topics were proposed: 'Migration,' 'Fellowships,' 'Subordinate Requirements for the Doctor's Degree,' 'The Printing of Dissertations.'

The Chairman of the Committee was authorized to appoint some person to prepare a statement of facts concerning each topic to be discussed. It was decided that one topic should be taken up for discussion at each session. It was voted that the Association should not appoint a representative for the Paris Exposition, and that it should not undertake at present to secure legislation with reference to the protection of higher degrees. The Federation of Graduate Clubs was given an opportunity to present statements in writing on the topics discussed in the Association.

GENERAL.

As we announced recently, a school of forestry is about to be established at Yale University. At a meeting of the corporation on March 16th, a gift of $150,000 for this purpose was acknowledged. The donors are Mr. and Mrs. J. W. Pinchot, and their sons, Mr. Gifford Pinchot, '89, and Mr. Amos. R. Pinchot, '97. The donors also authorized the use of a large tract of land in Pike County, Pa., for a summer school. Mr. Henry S. Graves, '92, has been appointed professor of forestry. Mr. Graves is assistant in the Division of Forestry, Department of Agriculture, of which Mr. Gifford Pinchot is chief.

Mr. Ezra Warner, of Chicago, has given $50,000 to Middlebury College, for a science building, the erection of which will be begun at once. Mr. Warner graduated from Middlebury College in 1861.

The Alumni of Haverford College have subscribed $40,000 for a gymnasium.

It has been decided that the new laboratory for physiology and anatomy at Cornell University, for which $80,000 was recently given, will be situated in the quadrangle east of Boardman Hall.

The bequest of about $2,000,000 by the Russian merchant, Mr. Astrachow for the establishment of a university for women at Moscow, has been accepted by the government. It is proposed first to establish faculties of medicine and of science.

The Michigan Gas Association at its annual meeting in Detroit, February 22d, raised a fund of six hundred dollars by individual subscription among the members to defray for one year the expenses, at the University of Michigan, of a graduate student who shall spend his time in research along some line of work connected with gas-making or the better utilization of by-products like coal-tar and ammonia. It is the intention of the association to support permanently a research fellowship at the University.

The corporation of Yale University has made alterations in the curriculum, enlarging the range of elective studies. The requirement of philosophy in the senior year is abandoned, and the range of electives in the sophomore year is enlarged. In the sophomore year ten subjects are offered of which five must be taken and one in addition may be taken. The subjects are, Greek, Latin, French, German, English, history, mathematics (two courses), chemistry and physics.

Arrangements have been made for a course on fish culture in connection with the Cornell University College of Forestry. It will be given during two weeks beginning May 7th at Axton in the College forest in the Adirondacks, and will be under the direction of Professor Barton W. Evermann of the United States Fish Commission. The course will consist in a series of daily lectures, with laboratory work, field excursions to the ponds, lakes and rivers, and visits to the State Hatchery at Clear Water, within a few hours of Axton. One or more lectures will be devoted to the following subjects: 1. Natural reproduction among fishes; manner of fertilization; conditions under which spawning takes place; dangers which beset the eggs, the fry and the young; necessity for artificial propagation; natural and artificial methods contrasted. 2. The species of fishes propagated artificially in America; the spawning time, place and habits of each, especially those native to the State of New York. 3. The Salmonidæ, or salmon trout and whitefish; methods of artificial propagation in detail. 4. The Black Bass and other centrarchidæ; methods of culture. 5. The Shad, Wall-eyed Pike, etc. 6. The care of fish fry. 7. Methods of shipment of eggs, fry, fingerlings and adults; how plants of fish are made. 8. Pollution of streams and lakes and fish protection. 9. Fish Culture in America, its history and results.

Courses in Commercial Education will next year be offered in the University of Michigan. (1) Diplomatic and consular education, (2) higher commercial education, (3) preparation for newspaper work, (4) preparation for pastoral work and public philanthropy, (5) instruction in public administration.

On the recommendation of Señor Barreiro, secretary for public instruction for Cuba, the school of engineering at Havana is to be reorganized.

We have already announced the resignation of the Rev. B. L. Whitman, president of Columbian University, Washington, which takes effect at the end of the present academic year. The Rev. Dr. Greene has been chosen president *pro tem.* and Professor H. L. Hodgkins (mathematics and physics) has been elected University Dean.

Dr. G. W. Myers, professor of astronomy at the University of Illinois, has resigned his chair to take charge of the department of astronomy and mathematics in the Chicago Institute.

Dr. Llewellys Barker, associate professor of anatomy at the Johns Hopkins Medical School, has accepted the chair of anatomy and neurology at the University of Chicago.

Dr. C. R. Bardeen, associate in anatomy of the University of California, has been appointed professor of this subject in the University of California.

Dr. John Ashhurst, Jr., has resigned the chair of surgery in the University of Pennsylvania.

Mr. G. T. Moody, D.Sc., F.C.S., has been appointed one of the Examiners in Chemistry in the College of Preceptors, London, in the place of Professor W. N. Hartley, F.R.S., who has retired.

Dr. Willy Bruhns, mineralogy and petrography, and Alexander Tornquist, geology and paleontology, docents at the University of Strassburg, have been appointed to associate professorships.

SCIENCE

Friday, March 30, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

EDUCATIONAL VALUES.*

History is always an attractive subject because it appeals to our sympathies. There is not one of us who has not been spurred to effort by the hope of reward, intellectual, moral, social, or material. Every one has at times enjoyed the consciousness of success, or suffered the sting of failure. The history of the race is the collective history of individuals. Every individual can in imagination put himself into the place of the actors who have left strong impressions on the world and been enrolled among the makers of history.

The history of education appeals less strongly to our feelings than does the recital of deeds that determined or destroyed men's leadership in the control of their fellows. But all of us have a very real interest in some of the educational problems of the day. From some points of view it is fortunate, from others, unfortunate, that the consideration of these problems implies conflict. We have all heard about a conflict, which is said to be very sanguinary, between the advocates of scientific study and those of liberal culture. I must confess that in my earliest manhood I rushed into this affray with all the joy and enthusiasm and self-confidence that a young man feels when he knows that he must be inflicting hard blows upon the adversary,

*An address before the student body of Washington and Lee University, February 14, 1900.

even if the adversary does not think them very hard. I had spent several years in mastering a certain amount of Latin, Greek, mathematics and a few other subjects of supposed minor importance. In regard to educational values my opinions were soon very decided; and the decision was by no means in favor of the curriculum through which I had been guided by my respected but mistaken friends, the professors. It is a familiar saying that "history repeats itself." Having stepped some years ago out of the young man's shoes into those of the professor, I am now at liberty to wonder how many students will go forth from this institution next summer, ready to prove that not only I myself, but all of my esteemed friends, my colleagues in this faculty, are old fogies.

The world cannot get along without young men. Perhaps it could, but it does not, get along without the old fogies. We have all heard of the man who was born tired. I have actually seen a good many men who were born old fogies, and who became superannuated before reaching middle age. I have seen others who had passed their three score years and ten without losing the passion for progress, the willingness to take in new ideas, the intellectual alertness of their youth. But certain it is that most of us need contact with young men to keep us from becoming too self-satisfied. The college professor has other duties besides pouring out knowledge and testing his students by written examinations. He must be tested by them; he must let them see that the reciprocity is not all on one side. As soon as he begins to think that he has nothing to learn from them, it becomes the proper time for him to step aside. They are his teachers so long as he retains the capacity to learn. They may make mistakes; but so does he. They are generally disposed to be progressive, if their independence has not been stifled by too great success in acquiring the habit of depending upon authority. If there is any one characteristic by which the scientific education of to-day is conspicuously in contrast with the so-called liberal education of two generations ago, it is found in the modern inculcation of the duty to be independent and manly, to use authorities as means and not as ends, and to accept no authority whatever as beyond question.

Let us go back for a moment then into ancient history and inquire into the origin of the worship which some of us were taught to offer to the fair goddess of liberal culture, the worship of a name while the actual culture was anything but liberal. It is not my wish to criticise our own conditions here; for happily the Washington and Lee University of to-day is so different from the Washington College of our grandfathers that they would find themselves much puzzled, perhaps even shocked, if they could step forth from their graves and visit us. The idea with which they were saturated was that the chief end of all education was discipline, and that a certain small number of subjects were inherently better for discipline than all else that related to human interests. If the young man were drilled until he could memorize a Greek play, a Latin oration, and a chapter of calculus, he was conventionally the possessor of liberal culture. The allowance was, as we now believe, very illiberal; but it was all that he could get. There were three liberal professions, divinity, law, and medicine, one of which he must select, but not one of which involved any special application of what he had studied in college. Vicarious discipline was, therefore, the sacred means by which he was to attain his earthly salvation.

Such an idea of education was accepted quite generally and cheerfully, because it was traditional and therefore respectable. It had been usual not only during the previous generation but during a hundred generations. Among the ancient Greeks the body was educated by gymnastic exercises, but this was confined chiefly to the aristocracy; for useful labor, involving bodily exercise and hence muscular development, was looked upon as menial and degrading. Intellectual education was regarded from the same standpoint. It might be a badge of gentility, but to seek useful knowledge was no more an educational object than to learn useful arts. Intellectual gymnastics for its own sake was a source of pleasure. To regard it as a source of profit would be to degrade it. "Not the game, but the excitement of the chase; not the truth, but the exhilaration of its pursuit, were the mottoes of culture. Under these circumstances no vulgar question of economy could arise; mental power was ostentatiously wasted, and with the necessary consequences,—truth unsought was not found; the ends of culture being ignored, there was neither conquest of nature nor progress of society."

Such ideals have continued potent to the present day. In mediæval times they were cultivated in the monasteries. It was for the support of them that universities gradually became organized. They are still dominant at Oxford and Cambridge in England, and in the universities of Germany, France and Italy. Their great value is readily conceded. If they constituted all that could be included in modern education, they would still be worth preserving and fostering. Under such ideals were educated some of the greatest men whose labors have advanced physical science, such as Newton, Huyghens and Laplace. The craving of humanity for intellectual exercise without reference to bread winning is as natural as the craving for food, or bodily activity, or companionship, the love of home, of family, or of country. The love of literature, of art, of science for its own sake, is conspicuously worthy of all commendation and encouragement. To know the best that has been thought and spoken and written, to appreciate the noblest and purest that the painter's brush has left upon canvas, to be capable of taking in the ideas and complex emotions that are conveyed in song and symphony, to apprehend the order and harmony that pervades a universe that is continually undergoing evolution in accordance with law—these are objects well worthy of our best efforts, irrespective of the remuneration that can be expressed in money or material power.

But the culture so eminently worthy of our seeking is not all that the world is justified in holding to be valuable. Why should such training be given in youth? It is not merely because the young are non-producers in society, but because they are more capable of modification than after maturity is reached. That the education to be given in youth should be a preparation for manhood is an idea that does not seem to have been well grasped by the educators in ancient or even comparatively recent times. Education was long reserved for the priesthood, rather than for the manhood of the people. Its underlying idea was the preservation of scholastic authority rather than the development of intellectual independence and moral power. It was intended to be a luxury for the few, while the masses were expected to keep on toiling in ignorance as had been done throughout untold centuries. The education of the English universities, even of this year 1900, is essentially aristocratic. Great stress is laid upon certain subjects, not because they afford the best culture, but because they are traditionally genteel, not because they confer power, but because they have long been fostered by the nobility. Even the army, officered by aristocrats who substituted gentility for military knowledge, has been this winter betraying its organic weakness in South Africa; and the liberally educated English have yet (February 14, 1900) to herald their first victory over the despised Boers, after four months of disastrous grappling. They will in time be victorious, but not by the application of what they have been taught through genteel traditions.

The educational system of a country should be adjusted to the needs of the majority of its people, and not be controlled by the nobility, whether this term be applied to the aristocracy of inherited rank, as in England, or of wealth, as in America. As soon as the question of educational values arises, therefore, we must ask ourselves, with candor and with utter disregard of genteel traditions, what kinds of knowledge are best fitted to develop mental, moral, and material power in our young men, recognizing the conditions of civilization as they exist to-day in the most prosperous parts of America. We are not to decry liberal culture; but we are abundantly justified in criticising the traditional limitations which have restricted the name of liberal culture quite arbitrarily to a certain group of studies. What is the ground upon which these studies have been called liberal? It is that they are now, and have long been, genteel; that they do not aim to help their votaries to make money; that their object is to produce such intellectual and social polish as money can not buy; that the stored-up capital which they represent must not yield interest in money, but only in culture; it must be totally independent of all commercial values.

This ideal was almost completely fulfilled during the many centuries of its dominance up to the nineteenth century. But commerce is stronger than an ideal. Is literary culture to-day without its pecuniary rewards? Is fine art practiced purely for the purpose of expressing the beautiful? So far as activity is expended for the cultivation of the true, the beautiful, and the good, the culture is liberal. So soon as the results of such activity cease to be given freely to the world, and become devoted to the acquisition of money, the name liberal ceases to be applicable. There are hundreds of men and women whose interests in college were concentrated upon literature, classics and history, and who apply the results of the mental discipline thus acquired, and the knowledge thus stored up, directly to the money-making business of writing novels. There are thousands more who are well paid for contributing to the newspapers such fiction as is euphemistically called news. All of it is called literary work, and the writers receive the credit of dwelling in an atmosphere of liberal culture. Fortunes have been made by judicious response to the popular demand for light literature, and the liberal culture disseminated is directly proportional to the liberal payment laid down in silver and gold. On the other hand there is an increasing number of young men who annually come forth from American universities, and yet more from German universities, whose time has been devoted to studies that by contrast are called scientific. They spend time and labor in the pursuit of science for its own sake. The results of their investigations are published in journals for which the general public has no use; and they receive no compensation for such contributions except the satisfaction of making themselves and their work known to the so-called scientific world. Their inquiries relate to subjects which have no commercial importance, and their object is without pay to enlarge the boundaries of human knowledge. Their stimulus is the pleasure of discovery, of investigation, of successful intellectual activity. The recognition they receive is such as money cannot possibly buy.

Nor have these scientific investigators been confined to the present century. Newton's Principia marked an epoch in science. It brought no money to its author, though succeeding generations have built upon it the remunerative science of navigation. Huyghens, Young, and Fresnel established the wave theory of light, the foundation of the now useful science of optics. They gave the products of their labor freely to the world, living economically, and dying with very small possessions. Gauss and Weber established the modern science of magnetism, while Volta, Oerstedt, Ampere, Ohm, Faraday, Henry, and Maxwell worked together and in succession to make electricity an exact science. They received no pecuniary rewards, but we to-day are reaping the fruits of their labors in the electrical industries that afford employment to a million of men and absorb hundreds of millions of capital. Shall we declare that these original investigators, these men of genius, were not representatives of liberal culture, merely because the subjects upon which their brain power was expended happened not to relate to literature, or linguistics, or art, or history? Some of these much decried scientific men, such as Tyndall, Huxley, and Darwin proved themselves to be adepts in the art of writing clear and forcible English. Were they devoid of culture? Tyndall knew little of Latin and nothing of Greek, but in the battle where tradition was arrayed against truth he displayed such culture and such vigor as to make him a match for more than one classically educated bishop.

The attempt to establish a line of division between science and liberal culture is an anachronism. We have outgrown the authority of our fathers who accepted the exclusive gentility of a certain group of studies and shrugged their shoulders at the young parvenue whom they called science. Let me here express my sympathy with the protest directed against the abuse of this comprehensive word, science. If the meaning of a word is determined by etymology, science merely means knowledge. It makes no difference whether the subject be chemistry, physics, economics, or philosophy; if the knowledge be definite, consistent and organized, it is science. If it be vague, if mere fancy is accepted as a substitute for fact, if dogma is balanced against demonstration, it is not science, it is not knowledge, though it may be brilliant imagination. But the meanings popularly attached to words are not determined by etymology. Whether rightly or wrongly, the word science has become restricted by tacit popular agreement to our knowledge of things in contrast with our knowledge of words or our speculations about ideals. When we appeal to nature our conclusions need verification before final acceptance. Those methods of investigation which imply verification are conventionally called scientific. If they become successfully applied to any subject whatever, the knowledge thus acquired becomes scientific.

Thanks to the scientific spirit that has leavened all modern institutions of learning, the scientific method is now increasingly applied to subjects which were formerly bound down by the shackles of tradition. It has raised to a high and dignified level subjects which were not recognized a generation ago as having any place in a liberal education. Prominent among these new sciences, these new elements of liberal culture, are political science and economics, equal in importance with physics and chemistry, even if they do not call for laboratory work. These new sister sciences may not be so traditionally genteel as the prim old sisters called classics and mathematics, but they are fresh, smiling and apparently quite irresistible.

The extent to which the old and traditional culture studies are giving place to modern and equally liberal culture studies is well shown by reference to last year's statistics at Yale University, an institution which was long one of the strongholds of conservatism. In all the higher educational institutions of the present day more or less liberty is accorded the student to elect at least some of the studies to which his time is to be devoted. The most popular subject at Yale last year was political economy, which was elected by 957 students. History was elected by 822, English by 529, philosophy by 398, modern languages by 266, classics, including both Latin and Greek by 172, and mathematics by 37. Under the head of natural science, including astronomy, physics, chemistry, geology and biology, the number of elections was 257. This certainly does not look as if the representatives of science, using this term in its conventional sense, are in a position to smile, either contemptuously or patronizingly, upon the devotees to so-called liberal culture.

The object of education is to make each one of us as nearly perfect a human being as he is capable of becoming. The great majority of those who begin to receive an education are restricted to elementary work. The determination of educational values depends in every case upon individual needs. Good mental discipline can be acquired by the systematic and earnest study of any subject whatever if the student has a living conviction of its importance, and the teacher has brains, enthusiasm, and skill. Any subject may be made a means of liberal culture if both teacher and student are stimulated by the love of knowledge. The law school, the medical school, the technological school are as necessary for the higher grades of professional culture as the college is for general culture. The student is not harmed but healthfully stimulated by his recognition of the vital importance to himself of what is drawing forth his best efforts. Let us welcome every new opportunity that is given our young men to adapt themselves to the requirements of modern life. No amount of declamation or invective can displace physical science from its present high position. Those of us who are devoted to science are willing and glad to clasp hands with all who are ready to go with us onward and upward.

No classification of educational values has been given that is superior to that that was expressed about forty years ago by one of the greatest of modern thinkers, Herbert Spencer. In the order of their relative importance the leading kinds of activity which constitute human life are grouped as follows:

1. Those which directly minister to self-preservation.

2. Those which, by securing the necessaries of life, indirectly minister to self-preservation.

3. Those which have for their object the rearing and training of the young.

4. Those which are involved in the maintenance of proper social and political relations.

5. Those which make up the leisure part of life, devoted to the gratification of the tastes and feelings.

The best education is the best preparation for all of these activities, its aim being to maintain a due proportion between the degrees of preparation in each. The order of relative importance is obviously the inverse of the order of diversity and complexity. It is not surprising therefore that up to a very recent time the work of educators has been confined chiefly to the last one of the groups of activities enumerated by Spencer. But in spite of educational traditions the world has lately been demanding attention to the other groups, and modern science as taught in our foremost universities and technical schools is the response to that demand. Mr. Spencer considers the educational needs implied for the best exercise of all these activities; and in answer to the question—What knowledge is most worth?—the answer is Science.

"For direct self-preservation, or the maintenance of life and health, the all important knowledge is—science. For that indirect self-preservation which we call gaining a livelihood, the knowledge of greatest value is—science. For the due discharge of parental functions, the proper guidance is to be found only in—science. For that interpretation of national life, past and present, without which the citizen cannot rightly regulate his conduct, the indispensable key is—science."—economics and political science. "For the most perfect production and highest enjoyment of art in all its forms the needful preparation is still—science. And for purposes of discipline, intellectual, moral, religious, the most efficient study is still—science."

It is not to be expected that these conclusions will be accepted by all to whom they are addressed. I should be the last to decry the importance of language study, of history, art, and philosophy. I emphatically emphasize the importance of national education in economics and political science. We are sadly in need of better political teachers than a majority of those who during the last few years have been the leaders in American politics. But I protest against the implication that liberal culture is suffering at the hands of either the active workers or the leading teachers in science. So long as human needs and human tastes are diversified must there be corresponding diversity in education. Let each of us recognize what is good in our neighbor, let us cheerfully and cordially acknowledge the value of his contribution to human welfare. Let us remember that there are others besides scientific men who are progressive, and that the boundaries of knowledge are without limit.

Within the present century one of the greatest mathematicians and astronomers that the world has ever known, Laplace, lay on his dying bed in Paris. His last words were: "Ce que nous savons est peu de choses; ce que nous ignorons est immense." It takes a philosopher to recognize the immensity of his own ignorance. If Laplace could use those words as he fell asleep, why can we not at least follow him and remain at peace with each other while striving to do our share in increasing human knowledge? Linguist and engineer, historian and chemist, economist and physicist, metaphysician and mathematician, our aims radiate from a common center; but friendly and faithful as we may be to each other, our ignorance will still continue to be immense.

W. LE CONTE STEVENS.

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*PICTURES PRODUCED ON PHOTOGRAPHIC PLATES IN THE DARK.**

I THINK I may fairly assume that every one in this theater has had his photograph taken, and consequently must have some idea of the nature of the process employed. I have, therefore, only to add, with regard to what is not visible in the process of taking the picture, that the photographic plate is a piece of glass or such like body, coated on one side by an adhesive paste which is acted on by light, and acted on in a very remarkable manner. No visible change is produced, and the picture might remain latent for years, but place this acted-on plate in a solution, of, say pyrogallol, and the picture appears. The subsequent treatment of the plate with sodium hyposulphite is for another purpose, simply to prevent the continuance of the action when the plate is brought into the light. Now, what I purpose demonstrating to you to-night is that there are other ways of producing pictures on photographic plates than by acting on them by light, and that by these other

* Address before the Royal Institution of Great Britain.

means a latent picture is formed, which is rendered visible in precisely the same way as the light pictures are.

The substances which produce on a photographic plate these results so strongly resembling those produced by light, are, some of them, metallic, while others are of vegetable origin. At first it seemed very remarkable that bodies so different in character should act in the same way on the photographic plate. The following metals—magnesium, cadmium, zinc, nickel, aluminium, lead, bismuth, tin, cobalt, antimony—are all capable of acting on a photographic plate. Magnesium most strongly, antimony but feebly, and other metals can also act in the same way, but only to a very slight extent. The action in general is much slower than that of light, but under favorable conditions a picture may be produced in two or three seconds.

Zinc is nearly as active as magnesium or cadmium, and is the most convenient metal to experiment with. In its ordinary dull state it is without the power of acting on a photographic plate, but scratch it or scrape it, and it is easy to prove that the bright metal is active. I would say that all the pictures which I have to show you, by means of the lantern, are produced by the direct action of the metal, or whatever the active body may be, on the photographic plate, and that they have not been intensified or touched up in any way. This first slide is the picture given by a piece of ordinary zinc which has been rubbed with some coarse sand-paper, and you see the picture of every scratch. Here is a piece of dull zinc on which some circles have been turned. It was exposed to the photographic plate for four hours at a temperature of 55°C. In the other cases, which are on a larger scale, a zinc stencil was polished and laid upon a photographic plate, and you see where the zinc was in contact with the plate much action has occurred. In another case a bright zinc plate was used, and a Japanese stencil interposed between it and the photographic plate, and a very strong and sharp picture is the result. The time required to produce these zinc pictures varies very much with the temperature. At ordinary temperature the exposure would have to be for about two days, but if the temperature was, say, 55°C., then half to three-quarters of an hour might be sufficient. Temperatures higher than this cannot be used except for very short times, as the photographic plate would be damaged. Contact between the zinc and photographic plate is not necessary, as the action readily takes place through considerable distances. Obviously, however, as you increase the distance between object and plate, so you decrease the sharpness of the picture, as is shown by the following pictures, which were taken respectively at a distance of 1 mm. and 3 mm. from the scratched zinc surface. The appearance of the surfaces of different metals varies, and the following slides show the surface of a plate of bismuth, a plate of lead and one of aluminium. On the next slide are the pictures produced by similar pieces of pure nickel and cobalt, and it clearly shows how much more active in this way nickel is than cobalt. Many alloys, such as pewter, fusible metal, brass, etc., are active bodies, and in the case of brass the amount of action which occurs is determined by the amount of zinc present. Thus you will see that a brass with 30 per cent. of zinc produces hardly any action on the photographic plate, but when 50 per cent. of zinc is present there is a fairly dark picture, and when as much as 70 per cent. is present a still darker picture is produced.

The second class of bodies which act in the same way on a photographic plate are organic substances, and belong essentially to the groups of bodies known as terpenes. In trying to stop the action of metallic zinc, which I thought at the time might arise from vapor given off by the metal, copal varnish was used, but in place of stopping the action it was found to increase it, and this increase of activity was traced to the turpentine contained in the varnish. In experimenting with liquids it is convenient to use small shallow circular glass vessels such as are made for bacteriological experiments, the plate resting on top of the vessel, and the amount of liquid in the vessel determining the distance through which the action shall take place. The following slide, produced in this way, shows how dark a picture ordinary turpentine produces. All the turpenes are active bodies. Dipentine is remarkably so; in a very short time it gives a black picture, and if the action be continued, the dark picture passes away, and you then have a phenomenon corresponding to what photographers call reversal. The strong smelling bodies known as essential oils, such as oil of bergamot, oil of lavender, oil of peppermint, oil of lemons, etc., are all active bodies, and all are known to contain in varying quantities different terpenes; therefore ordinary scents are active bodies, and this is shown by the following pictures produced by eau de Cologne, by cinnamon, by coffee, and by tea. Certain wines also act in the same way: Sauterne gives a tolerably dark picture, but brandy only a faint one. Other oils than these essential ones are also active bodies: linseed oil is especially so; olive oil is active, but not nearly as much so as linseed oil; and mineral oils, such as paraffine oil, are without action on the photographic plate.

Interesting results are obtained with bodies which contain some of these active substances; for instance, wood will give its own picture, as is shown by the following slides: the first is a section of a young spruce tree, the next a piece of ordinary deal, and the third of an old piece of mahogany. Again, the next slide you will recognize as the picture of a peacock's feather. There is much interest in these pictures of feathers, as they distinguish the brilliant interference colors from those produced by certain pigments; the beautiful blue in the eye of the peacock's feather is without action on the photographic plate. Butterflies' wings, at least some of them, will draw, as you see, their own pictures. Linseed oil, which is a constituent of all printing ink, makes it an active body, and it can, like the zinc and other active bodies, act through considerable distances. In the picture before you the ink was at a distance of one inch from the plate, and the next slide shows what a remarkably clear and dark picture ordinary printing can produce. As the composition of printing ink varies so does its activity, and here are pieces of three different newspapers which have acted under the same conditions on the same plate, and you see how different the pictures are in intensity. Printed pictures, of course, act in the same way—here is a likeness of Sir H. Tate taken from 'The Year's Art.' The pictures and printing in *Punch* always print well; so does the yellow ticket for the Friday evening lectures at the Royal Institution; also the rude trade-mark on Wills's tobacco, and it is of interest because the red pigment produces a very clear picture, but the blue printing is without action on the plate.

An interesting and important peculiarity of all these actions is that it is able to pass through certain media; for instance, through a thin sheet of gelatin. Here are two plates of zinc; both have been scratched by sand-paper; one is laid directly on the photographic plate, and the other one has a sheet of gelatin, its color is of no note, laid between it and the sensitive plate; the picture in this case is, of course, not so sharp as when no gelatin is present, but it is a good and clear likeness of the scratches.

Celluloid is also a body which allows the action to pass through it, as is seen in this picture of a piece of perforated zinc, a picture which was produced at ordinary temperatures. Gold-beaters' skin, albumen, collodion, gutta-percha, are also bodies which are transparent to the action of the zinc and the other active bodies. On the other hand, many bodies do not allow the transmission of the action through them; for instance paraffin does not, and among common substances writing-ink does not, as is easily shown by placing ordinary paper with writing on it between the active body and the photographic plate. The active body may conveniently be either a plate of zinc or a card painted with copal varnish and allowed to dry, or a dish of drying oil. The picture of an ordinarily directed envelope shows this opacity of ink well. It is a property long retained by the ink, as this picture of the direction of a letter, written in 1801, shows; also this letter of Dr. Priestley's, dated 1795; and here is also some very faded writing of 1810, which still gives a very good and clear picture. Even if the writing be on parchment, the action passes through the parchment, but not through the ink, and hence a picture is formed.

With bodies which are porous, such as most papers, for instance, the action passes gradually through the interstices, and impresses the plate with a picture of the general structure of the intervening substance. For instance, the following pictures show the structure and the water-mark of certain old and modern writing-papers. Some modern writing-papers are, however, quite opaque; but usually paper allows the action to take place through it, and combining this fact with the fact of strong activity of the printing-ink, the apparently confused appearance produced on obtaining a picture from paper with printing on both sides is accounted for, as the printing on the side away from the photographic plate, as well as that next to it, prints through the paper, and is, of course, reversed.

I hope I have now given you a clear idea how a picture can be produced on a photographic plate in the dark, and the general character and appearance of such pictures. I now pass on to the important question of how they are produced. Moser suggested fifty years ago that there was 'dark light,' which gave rise to pictures on polished metallic plates, and lately it was suggested that pictures were produced by vapor given off by the metals themselves; the explanation, however, which I have to offer you is, I think, simpler than either of these views, for I believe that the action on the photographic plate is due to the formation of a well-known chemical compound, hydrogen peroxide, which undergoing decomposition acts upon the plate and is the immediate cause of the pictures formed. The complicated changes which take place on the sensitive plate I have nothing to say about on the present occasion, but I desire to convince you, that this body, hydrogen peroxide, is the direct cause of these pictures produced in the dark. Indirect proof has to be resorted to. Water cannot be entirely excluded, for an absolutely dry photographic plate would probably be perfectly inactive, and as long as water is present peroxide of hydrogen may be there also. But what are the conditions under which these pictures are formed? Only certain metals are capable of producing them. This list of active metals which I have mentioned to you was determined solely by experiment, and when completed it was not evident what common property bound them together. Now, however, the explanation has come for these are the very metals which most readily cause, when exposed to air and moisture, the formation of this body peroxide of hydrogen. Schönbein showed as long ago as 1860 that when zinc turnings were shaken up in a bottle with a little water hydrogen peroxide was formed, and the delicate tests which we now know for this body show that all the metals I named to you not only can in the presence of moisture produce it, but that their power of doing so follows the same order as their power of acting on a photographic plate. Again, what happened with regard to the organic bodies which act on the photographic plates? I have already mentioned that in experimenting with the metals it was accidentally observed that copal varnish was an active substance producing a picture like that produced by zinc, and that the action was traced to the turpentine present; again a process very much like groping in the dark had to be carried on in order to determine which were active and which inactive organic bodies, and the result obtained was that the active substances essentially belonged to the class of bodies known to chemists as terpenes. Now a most characteristic property of this class of bodies is that in presence of moisture and air they cause the formation of hydrogen peroxide, so that whether a metal or an organic body be used to produce a picture, it is in both cases a body capable, under the circumstances, of causing the formation of hydrogen peroxide. Passing now to experimental facts, which confirm this view of the action on sensitive plates, I may at once say that every result obtained by a metal or by an organic body can be exactly imitated by using the peroxide itself. It is a body now made in considerable quantity, and sold in solution in water. Even when in a very dilute condition it is extremely active. One part of the peroxide diluted with a million parts of water is capable of giving a picture. It can, of course, be used in the glass dishes like any other liquid, but it is often convenient not to have so much water present; and then it is best to take white blotting paper, wet it in the solution of the peroxide, and let it dry in the air. The paper remains active for about twenty-four hours; or, what is still better, take ordinary plaster of Paris, wet it with the peroxide solution, and let it set 'in a mould' so as to get a slab of it. This slab increases in activity for the first day or two after making, and retains its activity for a fortnight or more. Such a slab will give a good and dark picture in three or four seconds.

To show how similar the pictures produced by the peroxide and those by zinc are, pictures of a Japanese paper stencil, which had been paraffined to make it quite opaque, have been made by both processes, and are shown with other instances in which turpentine was used in the following slides. It is also very easy to obtain good pictures with the peroxide alone of the structure of paper, etc.; see, for instance, this one of a five-pound note and these of lace. Again, the strict similarity between the action of the peroxide and that of the metals and organic bodies is further shown by the fact that its action passes through the same media as their action does; and here are good pictures formed by the action of the peroxide after passing through a sheet of these substances. How this singular transmission can be explained, I have treated of elsewhere, and time does not allow of my discussing the matter to-night.

There are many ways in which the bright, active zinc surface can be modified. Draw your finger across it, press your thumb upon it, and you stop its activity, as is shown by the picture it will give. Lay a printed paper on the zinc, and let the contact continue for three-quarters of an hour, at a temperature of 55°, then bring the zinc in contact with a sensitive plate, a picture of the printing is formed, but allow the contact between the zinc and printing to continue for eighteen hours at the same temperature, and the picture then given by the zinc is the reverse of the former one.

Where the ink has been is now less active than the rest of the plate. Here are slides which show these positive and negative pictures. Another way of modifying the zinc surface is interesting. You have seen that the ordinary zinc surface which has been exposed to air and moisture is quite inactive, but if a bright piece of zinc be immersed in water for about twelve hours, the surface is acted on; oxide of zinc is formed, showing generally a curious pattern. Now if the plate be dried, it will be found that this oxide is strongly active, and gives a good picture of the markings on the zinc. The oxide evidently holds, feebly combined or entangled in it, a considerable quantity of the hydrogen peroxide, and it requires long drying or heating to a higher temperature to get rid of it. Also, if a zinc plate be attacked by the hydrogen peroxide, the attacked parts become more active than the bright metal. Thus place a stencil on a piece of bright zinc, and expose the plate to the action of an active plaster of Paris slab, or to active blotting-paper for a short time, then, on removing the stencil, the zinc plate will give a very good picture of the stencil. Any inactive body—for instance, a piece of Bristol board or any ordinary soft paper—can be made active by exposing it above a solution of peroxide, or, more slowly, by exposing it to a bright zinc surface. If, for instance, a copper stencil be laid on a piece of Bristol board, and a slab of active plaster of Paris be placed on the stencil for a short time, the Bristol board will even, after it has been removed from the stencil for some time, give a good picture of the stencil. Drying oil and other organic bodies may be used in the same way to change the paper. A curious case of this occurred in printing a colored advertisement cut out of a magazine, for there appeared printing in the picture which was not in the original. This printing was ultimately traced to an advertisement on the opposite page, which had been in contact with the one which was used; thus this ghostly effect was produced.

I believe, then, that it is this active body, hydrogen peroxide, which enables us to produce pictures on a photographic plate in the dark. There are many other curious and interesting effects which it can produce, and which I should like to have shown you, had time permitted.

I would only add that this investigation has been carried on in the Davy Faraday Laboratory of this Institution.

WILLIAM JAMES RUSSELL.

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*DEGENERATION IN THE EYES OF THE COLD-BLOODED VERTEBRATES OF THE NORTH AMERICAN CAVES.**

"DEGENERATION," says Lankester, "may be defined as the gradual change of the structure in which the organism becomes adapted to less varied and less complex conditions of life; whilst elaboration is a gradual change of structure in which the organism becomes adapted to more and more varied and complex conditions of existence."

Degeneration may affect the organism as a whole or some one part. I propose to speak not on degeneration in general but to give a concrete example of the degeneration of the parts of one organ.

The eyes of the blind vertebrates of North America lend themselves to this study admirably because different ones have reached different stages in the process, so by studying them all we get a series of steps through which the most degenerate has passed. This enables us to reach conclusions

* Presidential address at the meeting of the Indiana Academy of Sciences, Dec. 27, 1899. The detailed account of the eyes, whose general features are given here, has in part been published in Roux's Archiv f. Entwickelungsmechanik, VIII., and will in part be published in the Proceedings Am. Microscopical Society for 1899.

that the study of an extreme case of degeneration would not give.

I shall confine myself to the cave salamanders and the blind fishes (Amblyopsidæ) nearly all of which I have visited in their native haunts. The salamanders are introduced to illuminate some dark points in the degeneration of the eyes of the fishes and to emphasize a fact that is forcing itself forward with increasing vehemence, *i. e.*, that cross-country conclusions are not warrantable, that the blind fishes form one group and the salamanders other groups, and that, however much one may help us to understand the other, we must not expect too close an agreement in the steps of their degeneration under similar conditions.

There are three cave salamanders in North America.

1. *Spelerpes maculicauda* is found generally distributed in the caves of the Mississippi valley. It so closely resembles *Spelerpes longicauda* that it has not until more recent years been distinguished from the latter which has an even wider epigæan distribution. There is nothing about the structure of this salamander that marks it as a cave species but its habits are conclusive.

2. *Typhlotriton* is much more restricted in its distribution, being confined to a few caves in southwestern Missouri. I have taken its larvæ at the mouth of Rock House cave in abundance. In the deeper recesses of Marble cave I secured both young and adult. This is a cave species of a more pronounced type. The very habit that accounts for the presence of salamanders in caves has been retained by this one. I found some individuals hiding (?) under rocks and in the aquarium their steriotropic nature manifests itself by the fact that they crawl into glass tubing, rubber tubing or under wire screening. In the eye of this species we have some of the early steps in the process of degeneration.

3. *Typhlomolge* has been taken from a surface well near San Marcos, Texas, and from the artesian well of the U. S. Fish Commission which taps a cave stream about 190 feet from the surface. It has also been seen in the underground stream in Ezel's cave near San Marcos. It was also reported to me from south of San Antonio, Texas. This is distinctly and exclusively a cave species and its eyes are more degenerate than those of any other salamander, including the European Proteus.*

The Amblyopsidæ are a small family of fresh water fishes and offer exceptional facilities for the study of the steps in the degeneration of eyes. There are at least six species and we have gradations in habits from permanent epigæan species to species that have for ages been established in caves.

The species of *Chologaster* possess well developed eyes. One of them, *C. cornutus*, is found in the coast streams of the southeastern States; another, *C. papilliferus*, is found in some springs in southwestern Illinois, while the third, *C. agassizii* lives in the cave streams of Kentucky and Tennessee.

The other members of the family are cave species with very degenerate eyes. They represent three genera which are descended from three epigæan species. *Amblyopsis*, the giant of the race, which reaches 135

*It may be noticed that the eyes of the western *Typhlotriton* are more degenerate than those of the cave *Spelerpes* of wider distribution. Further the eyes of the Texan *Typhlomolge* are more degenerate than those of the Missouri *Typhlotriton*. Now similarly the Missouri blind fish *Troglichthys* has eyes in a much more advanced state of degeneration than the Ohio valley blind fishes. It is possible that the explanation is to be found in the length of time the caves in these regions have been habitable. During the glacial epoch the caves of the Ohio valley were at or near the northern limit of vegetation. The Missouri caves, if affected by glaciation, must have become habitable before those of the Ohio valley, while those of Texas were probably not affected at all.

mm. in length, is found in the caves of the Ohio Valley. *Typhlichthys* is also found in the Ohio Valley but chiefly south of the Ohio river. But a single specimen has been found north of the Ohio and this represents a distinct species. *Troglichthys* which is found in the caves of Missouri, has been in caves longer than its relatives if the degree of degeneration of its eyes is a criterion.

Before dealing with the degeneration of the eye a few words are in order on the normal structure of the organ under consideration.

In the normally developed eye we may distinguish a variety of parts with different functions. These are:

A. Organs for protection like the lid and orbits.

B. Organs for moving the eye to enable it to receive direct rays of light. In the cold-blooded vertebrates these consist of four rectus muscles and two oblique.

C. Organs to support the active structures, the fibrous or cartilaginous sclera.

D. The eye itself consisting of:

1. Parts for transmitting and focusing light; the cornea, lens and vitreous body.

2. Parts for receiving light and transforming it to be transmitted to the brain; the retina.

3. A part for transmitting the converted impression to the brain; the optic nerve.

Some of these as the muscles, retina and optic nerve are active while others, the protective and supporting organs, are passive.

A. In the Amblyopsidæ the skin passes directly over the eye without forming a free orbital rim or lid. The skin over the eye in *Chologaster* is much thinner than elsewhere and free from pigment. In the other species of the family the eye has been withdrawn from the surface. In these it lies deep beneath the skin and the latter where it passes over the eye, has assumed the structure normal to it in other parts of the head.

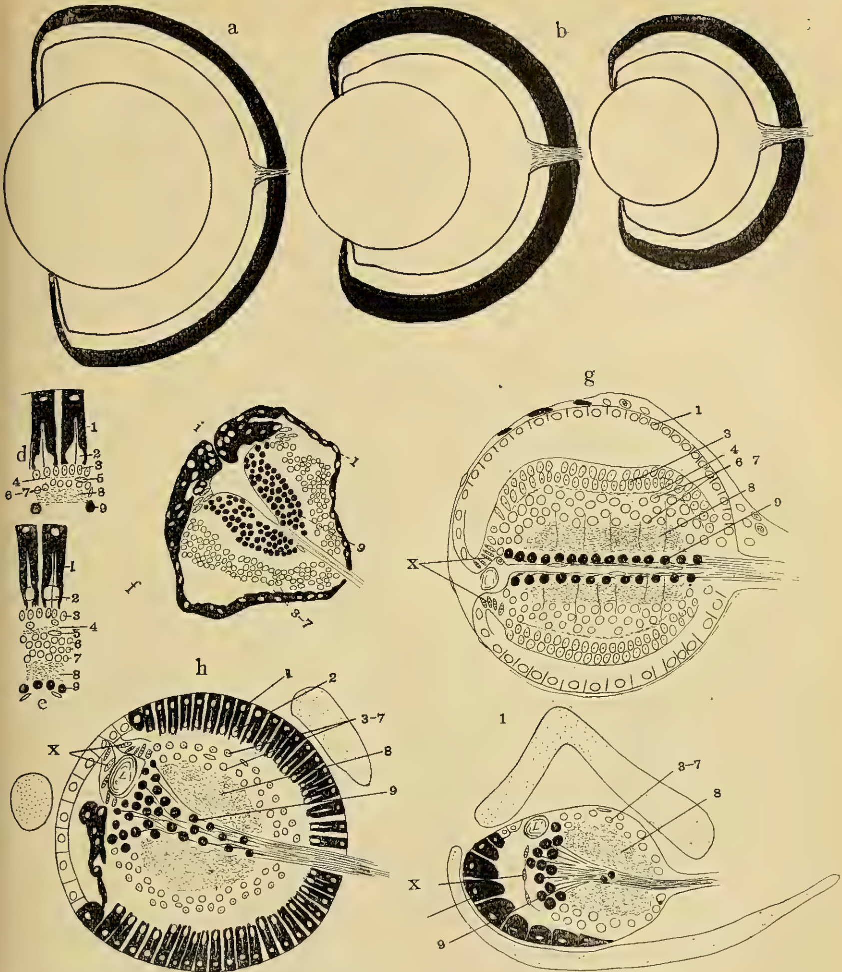
In the salamanders we have a perfect gradation in the matter of the eye-lids. In *Spelerpes* a free orbital rim is present in every respect like that found in epigæan salamanders. In *Typhlotriton* the lids are closing over the eye. The slit between the upper and lower lid is much shorter than normally and the upper lid overlaps the lower. The conjunctiva is still normal. The eye of this species is midway between the normal salamander eye and that of *Typhlomolge*, in which a slight thinning of the skin is all there is to indicate its former modification over the eye.

B. The muscles to change the direction of the eye-ball show complete gradations from perfect development to total disappearance.

In the species of *Chologaster* all the muscles are normally developed. In *Amblyopsis* the muscles are unequally developed, but one or more are always present and can be traced from their origin to the eye. In *Troglichthys*, the distal halves of the muscles, the parts nearest the eye have been replaced by connective tissue fibers, *i. e.*, a tendon has replaced part of the muscle. Here we have a step in advance in the degeneration found in *Amblyopsis* and no instance was noticed where *all* the muscles of any eye were even developed in the degree described. In *Typhlichthys* the muscles have all disappeared.

In *Typhlomolge* the muscles have disappeared; in the other salamanders they are present.

C. The sclera is differently developed in *Chologaster*, and there is but little modification in the species with more degenerate eyes except that in *Amblyopsis* and *Troglichthys*, where cartilaginous bands were evidently present in the epigæan ancestors. These bands have persisted in a remarkable degree, being much too large for the minute eyes with which they are connected. In *Troglichthys* they form a hood over the front



a to *i*. Diagrams of the eyes of all the species of the Amblyopsidæ and of Typhlomolge.

a to *c* are the eyes of *Chologaster cornutus*, *papilliferus* and *agassizii* drawn to scale.

d, *e*, *g*, *h* and *i* are drawn under the same magnification.

d. The retina of *Chologaster cornutus*.

e. The retina of *Chologaster papilliferus*.

f. The eye of *Typhlomolge* under lower magnification.

g. The eye of *Typhlichthys subterraneus*.

h. The eye of *Amblyopsis spelæus*.

i. The eye of *Troglichthys rosæ*.

of the eye, and various projections and angles in their endeavor to accommodate themselves to the small structure which they cover.

This is in striking contrast to the conditions in *Typhlotriton*, where but a slight nodule of cartilage remains and this is very frequently absent in the adult, while in the larva of the same species a cartilaginous band extends almost around the equator of the eye. The different effect of degeneration in the Amblyopsidæ and the salamanders could not be more forcibly illustrated than by the scleral cartilages.*

D. The eye as a whole and its different parts may now be considered.

1. The dioptric apparatus.

The steps in degeneration of the eye in general are indicated in the accompanying figure.

The most highly developed eye is that of *Chologaster papilliferus*. The parts of this eye are well proportioned, but the eye as a whole is small, measuring less than one millimeter in a specimen 55 mm. long. The proportions of this eye are symmetrically reduced if it has been derived from a fish eye of the average size, but the retina is much simpler than in such related pelagic species as *Zygonectes*. The simplifications in the retina have taken place between the outer nuclear and the ganglionic layers. The pigment layer has not been materially affected. These facts are exactly opposed to the supposition of Kohl that the retina and the optic nerve are the last to be affected and that the vitreous body and the lens cease to develop early. In *Chologaster papilliferus* the latter parts are normal, while the retina is simplified. That the retina is affected first is proved beyond cavil by *Chologaster cornutus*. The vitreous body and the lens are here larger than *papilliferus*, but the retina is very greatly simplified. *Cornutus*, it must be borne in mind, lives in the open. The eye of the cave species *Chologaster agassizii* differs from that of *papilliferus* largely in size. There is little difference in the retinas except the pigmented layer, which is about 26 per cent. thinner in *agassizii* than in *papilliferus*.

* The presence of a cartilaginous band in the young is, possibly, a larval character, and its absence in the adult has, in that case, no bearing on degeneration.

There is a big gap between the lowest eye of *Chologaster* and the highest eye of the blind members of the Amblyopsidæ. The lens in the latter has lost its fibrous nature and is merely an ill-defined minute clump of cells scarcely distinguishable in the majority of cases. The vitreous body of the latter species is gone with perhaps a trace still remaining in *Typhlichthys*. With the loss of the lens and the vitreous body the eye collapsed so that the ganglionic layer formerly lining the vitreous cavity has been brought together in the center of the eye.

The layers of the retina in *Typhlichthys* are so well developed that could the vitreous body and lens be added to this eye it would stand on a higher plane than that of *Chologaster cornutus*, exclusive of the cones and pigmented layer. It is generally true that at first the thickness of the layers of the retina is increased as the result of the reduction of the lens and vitreous body and the consequent crowding of the cells of the retina whose reduction in number does not keep pace with the reduction in the dioptric apparatus in total darkness.

If we bear in mind that no two of the eyes represented here are members of a phyletic series, we may be permitted to state that from an eye like that of *cornutus*, but possessing scleral cartilages, both the eyes of *Amblyopsis*, and *Troglichthys* have been derived and that the eye of *Amblyopsis* represents one of the stages through which the eye of *Troglichthys* passed. The eye of *Amblyopsis* is the eye of *C. cornutus* minus a vitreous body with the pupil closed and with a minute lens or none at all. The nuclear layers have gone a step further in their degeneration than in *cornutus*, but the greatest modification has taken place in the dioptric arrangements.

In *Troglichthys* even the mass of ganglionic cells present in the center of the eye as the result of the collapsing after the removal of the vitreous body has vanished. The pigmented epithelium, and, in fact, all the other layers, are represented by mere fragments.

The eye of *Typhlichthys* has degenerated along a different line. There is an almost total loss of the lens and vitreous body in an eye like that of *papilliferus* without an intervening stage like that of *cornutus*, and the pigment layer has lost its pigment, whereas in *Amblyopsis* it was retained.

The salamanders bridge the gap existing between the *Chologasters* and the blind members of the Amblyopsidæ. But even at the risk of monotonous repetition I want again to call attention to the fact that the salamanders do not belong to the same series as the Amblyopsidæ. The dioptric arrangements of *Typhlotriton* are all normal, the retina is normal in the young, but the rods and cones all disappear with the change from the larval to the adult condition. In *Typhlomolge*, the lens and largely the vitreous body are gone and the eye has collapsed. The vitreous body is, however, much better represented than in the blind Amblyopsidæ and the iris is, especially in the young, much better developed than in the fishes.

2. The retina.

(*a*) There is more variety in the degree of development of the pigment epithelium than in any other structure of the eye. Ritter has found that in *Typhlogobius* this "layer has actually increased in thickness concomitantly with the retardation in the development of the eye, or it is quite possible with the degeneration of this particular part of it. An increase of pigment is an incident to the gradual diminution in functional importance and structural completeness." There is so much variation in the thickness of this layer in various fishes that not much stress can be laid on the absolute or relative thickness of the pigment in any one species as an index of degeneration. While the pigment layer is relative to the rest of the retina, very thick in the species of *Chologaster* it is found that the pigment layer of *Chologaster* is actually not much, if any, thicker than that of *Zygonectes*; exception must be made for specimens of the extreme size in *papilliferus* and *agassizii*. In other words, primarily the pigment layer has retained its normal condition while the rest of the retina has been simplified and there may even be an increase in the thickness of the layer as one of its ontogenic modifications. Whether the greater thickness of the pigment in the old *Chologaster* is due to degeneration or the greater length of the cones in a twilight species, I am unable to say. In *Typhlichthys*, which is undoubtedly derived from a *Chologaster*-like ancestor, no pigment is developed. The layer retains its epithelial nature and remains apparently in its embryonic condition. It may be well to call attention here to the fact that the cones are very sparingly developed, if at all, in this species. In *Amblyopsis*, in which the degeneration of the retina has gone further but in which the cones are still well developed, the pigment layer is very highly developed, but not by any means uniformly so in different individuals. The pigment layer reaches its greatest point of reduction in *rosæ* where pigment is still developed, but the layer is fragmentary except over the distal part of the eye. We thus find a development of pigment with an imperfect layer in one case (*Troglichthys*) and a full developed layer without pigment in another (*Typhlichthys*). In the *Chologasters* the pigment is in part prismatic; in the other species granular.

(*b*) In the outer nuclear layer a complete series of steps is observable from the two-layered condition in *papilliferus* to the one-layered in *cornutus*, to the undefined layer in *Typhlichthys* and the merging of the nuclear in *Amblyopsis*, and their occasional total absence in *Troglichthys*. The rods disappear first, the cones long before their nuclei.

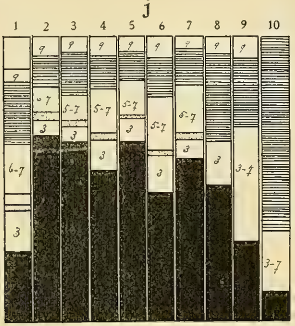


Diagram showing the per cents. of the total thickness of each of the layers of the retina in 1. *Zygonectes notatus*. 2. *Chologaster cornutus* 27 mm. long. 3. 43 mm. long. 4. *Chologaster papilliferus* 29–39 mm. and 5., 55 mm. long. 6. *Chologaster agassizii* 38 mm. long and 7., 62 mm. long. 8. *Amblyopsis*. 9. *Typhlichthys*. 10. *Troglichthys*.

(*c*) The outer reticular layer naturally meets with the same fate as the outer nuclear layer. It is well developed in *papilliferus*, evident in *C. cornutus*, developed in spots in *Typhlichthys*, and no longer distinguishable in other species.

(*d*) The layers of horizontal cells are represented in *papilliferus* by occasional cells; they are rarer in *cornutus* and beyond these have not been detected.

(*e*) The inner nuclear layer of bipolar and spongioblastic cells is well developed in *papilliferus*. In *cornutus* it is better developed in the young than in the older stages where it forms but a single layer of cells. There is evidently in this species an ontogenic simplification. In the remaining species it is, as mentioned above, merged with the outer nuclear layer into one layer which is occasionally absent in *Troglichthys*.

(*f*) The inner reticular layer is relatively better developed than any of the other layers and the conclusion naturally forces itself upon one that it must contain other elements besides fibers of the bipolar and ganglionic cells, for, in *Amblyopsis* and *Troglichthys*, where the latter are very limited or absent, this layer is still well developed. Horizontal cells in this layer have only been found in the species of *Chologaster*.

(*g*) In the ganglionic layer we find again a complete series of steps from the most perfect eye to the condition found in *Troglichthys*. In *papilliferus* the cells form a complete layer one cell deep except where the cells have given way to the optic fiber tracts which pass in among the cells instead of over them. In *cornutus* the cells have been so reduced in number that they are widely separated from each other. With the loss of the vitreous cavity the cells have been brought together again into a continuous layer in *Typhlichthys*, although there are much fewer cells than in *cornutus* even. The next step is the formation of a solid core of ganglionic cells and the final step the elimination of this central core in *Troglichthys*, leaving but a few cells over the anterior face of the retina.

(*h*) Müllerian nuclei are found in all but *Troglichthys*. In *C. cornutus* they lie in part in the inner reticular and the ganglionic layer. Cells of this sort are probably also found among the ganglionic cells of *Typhlichthys*.

3. The optic nerve shows a clear gradation from one end of the series of fishes to the other. In *Chologaster papilliferus* it reaches its maximum development. In *cornutus* which possesses an eye larger than *papilliferus*, but in which the ganglionic

layer is simplified, the nerve is measurably thinner. In *Typhlichthys* the nerve can be traced to the brain in specimens 40 mm. long, *i. e.*, in specimens which are evidently adult. In *Amblyopsis* the nerve can be followed to the brain in specimens 25 mm. long, but in the adult I have never been able to follow it to the brain. In *Troglichthys* it has become so intangible that I have not been able to trace it far beyond the eye.

We thus see that the simplification or reduction in the eye is not a horizontal process. The purely supporting structures like the scleral cartilages have been retained out of all proportion to the rest of the eye. The pigment layer has been both quantitatively and qualitatively differently affected in different species. There was primarily an increase in the thickness of this layer and later a tendency to total loss of pigment. The degeneration has been more uniformly progressive in all the layers within the pigment layer. The only possible exception being the inner recticular layer which probably owes its retention more to its supporting than to its nervous elements. Another exception is found in the cones, but their degree of development is evidently associated with the degree of development of the pigmented layer. As long as the cones are developed the pigmented layer is well developed or *vice versa*.

We find in general then that the reduction in size from the normal fish eye went hand in hand with the simplification of the retina. There was at first chiefly a reduction in the number of many times duplicated parts. Even after the condition in *Chologaster papilliferus* was reached, the degeneration in the histological condition of the elements did not keep pace with the reduction in number (*vide*, the eye of *cornutus*). The dioptric apparatus disappeared rather suddenly and the eye as a consequence, collapsed with equal suddenness in those members which, long ago, took up their abode in total darkness. The eye not only collapsed, but the number of elements decreased very much. The reduction was in the horizontally repeated elements. The vertical complexity, on which the function of the retina really depends, was not greatly modified at first.

In those species which took up their abode in total darkness the degeneration in the dioptric apparatus was out of proportion to the degeneration of the retina, while in those remaining above ground the retinal structures degenerated out of proportion to the changes in the dioptric apparatus, which, according to this view degenerates only under conditions of total disuse or total darkness which would necessitate total disuse. This view is upheld by the conditions found in *Typholgobius*, as Ritter's drawings and my own preparations show. In *Typholgobius* the eye is functional in the young and remains a light perceiving organ throughout life. The fish live under rocks between tide water (Eigenmann, 90). We have here an eye in a condition of partial use and the lens is not affected. The retina has, on the other hand, been horizontally reduced much more than in the Amblyopsidæ, so that should the lens disappear, and Ritter found one specimen in which it was gone, the type of eye found in *Troglichthys* would be reached without passing through a stage found in *Amblyopsis*, it would be simply a horizontal contracting of the retina, not a collapsing of the entire eye.

The question may with propriety be asked here, do these most degenerate eyes approach the condition of the pineal eye? It must be answered negatively.*

* The degree of degeneration reached in the eye of *Troglichthys* which began to degenerate comparatively recently would lead one to expect the pineal eye to be much more degenerate than it is actually found to be in the lizards unless its functions were something aside from light perception.

Ontogenic degeneration.

The simplification of the eye in *cornutus* with age has been mentioned in the foregoing paragraphs. The nuclear layers are thinner in the old than in the young. There is here not so much an elimination or destruction of elements as a simplification of the arrangements of parts, comparatively few being present to start with.

The steps in ontogenic degeneration can not yet be given with any degree of finality for *Amblyopsis* on account of the great variability of the eye in the adult. While the eyes of the very old have unquestionably degenerated, there is no means of determining what the exact condition of a given eye was at its prime. In the largest individual examined the eye was on one side a mere jumble of scarcely distinguishable cells, the pigment cells and scleral cartilages being the only things that would permit its recognition as an eye. On the other side, the degree of development was better. The scleral cartilages are not affected by the degenerative processes and are the only structures that are not. The fact that the eyes are undergoing ontogenic degeneration may be taken, as suggested by Kohl, that these eyes have not yet reached a condition of equilibrium with their environment or the demands made upon them by use. Furthermore, the result of the ontogenic degeneration is a type of structure below anything found in phylogeny. It is not so much a reduction of the individual parts as it is a wiping out of all parts.

PLAN AND PROCESS OF PHYLETIC DEGENERATION.

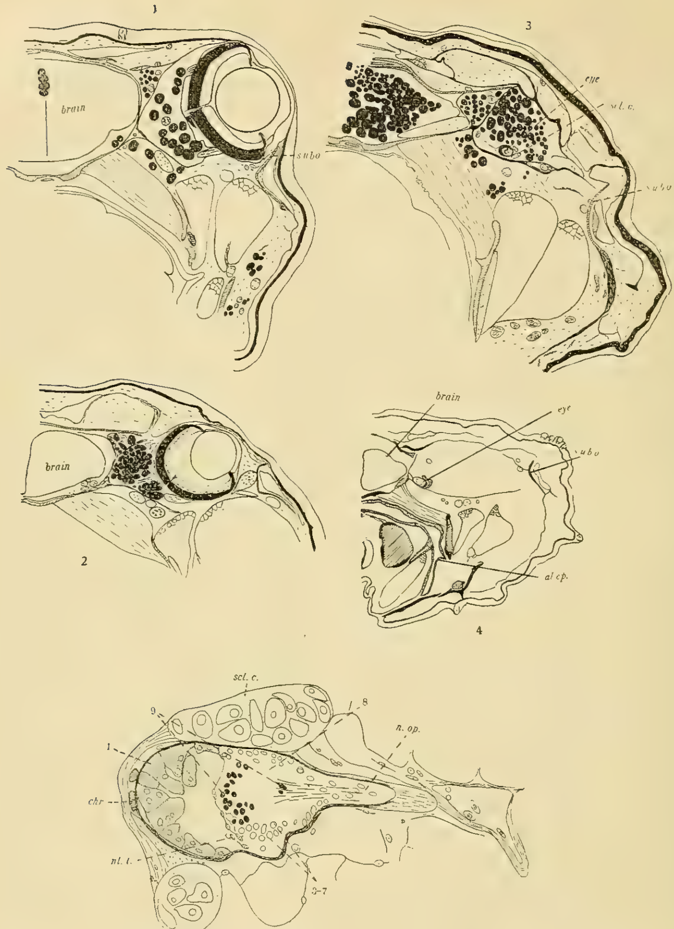
Does degeneration follow the reverse order of development, or does it follow new lines, and if so, what determines these lines?

Before discussing this point I should like to call attention to some of the processes of ontogenic development concerned in the development of the eye. There are three processes that are of importance in this connection: 1. The multiplication of cells. 2. The arrangement of cells including all the processes leading to morphogenesis. Frequently the first process continues after the second one has been in operation. 3. Lastly we have the growth and modification of the cells in their respective places to adapt them to the particular function they are to subserve—histogenesis.

Since the ontogenetic development of the eye is supposed to follow in general lines its phylogenetic development the question resolves itself into whether or not the eye is arrested at a certain stage of its development and whether this causes certain organs to be cut off from development altogether. In this sense the question has been answered in the affirmative by Kohl. Ritter, while unable to come to a definite conclusion, notes the fact that in one individual of *Typhlogobius* the lens, which is phylogenetically a new structure, had disappeared. But this lens had probably been removed as the result of degeneration rather than through the lack of development.

Kohl supposes that in animals placed in a condition where light was shut off, more or less, some of the developmental processes are retarded. In successive generations earlier and earlier processes in the development of the eye are retarded and finally brought to a standstill; thus every succeeding generation developed the eye less. Total absence of light must finally prevent the entire *anlage* of the eye, but time, he thinks, has not been long enough to accomplish this in any vertebrate. The cessation of development does not take place at the same time in all parts of the eye. The less important, those parts not essential to the perception of light, are disturbed first. The retina and the optic nerve are the least affected, the iris comes next in the series. Because the cornea, aqueous and vitreous bodies and the lens are not essential for the performance of the function of the eye, these structures cease to develop early. The processes of degeneration follow the same rate. Degeneration is brought about by the falling apart of the elements as the result of the introduction of connective tissue cells that act as wedges. Abnormal degeneration sometimes becomes manifest through the cessation of the reduction of parts that normally decrease in size (p. 269), so that these parts in the degenerate organ are unusually large.

Kohl's theoretical explanation is based on the study of an extensive series of degenerate eyes. He has not been able to test the theory in a series of animals actually living in the condition he supposes for them, and has permitted his erroneous interpretation of the highly degenerate eye of *Troglichthys* to lead him to the theory of the arresting of the eye in ever-earlier stages of ontogeny. The eye of *Troglichthys* is in an entirely different condition from that supposed by him. The mere checking of the normal morphogenic development has done absolutely nothing to bring about this condition and it could not have been produced by the checking of development in ever earlier and earlier stages of ontogeny, for there is no stage in normal ontogeny resembling in the remotest degree the eye of the adult *Troglichthys*. The process of degeneration as seen in the Amblyopsidæ is in the first instance one of growing smaller and simpler (not more primitive) in the light—not a cutting off of late stages in the development in the dark. The simplified condition, it is true, appears earlier and earlier in ontogeny till it appears along the entire line of development, even in the earliest stages. This simplified condition never gives any evidence of being more primitive; it is simply less elaborate. The tendency for characters added or modified at the end of ontogeny to appear earlier and earlier in the ontogeny is well known, and there is no inherent reason why an organ disappearing in the adult should not eventually disappear entirely from ontogeny. The fact that organs which have disappeared in the adult, have in many instances not also disappeared in the ontogeny and remain as so-called rudimentary organs has received an explanation from Sedgwick. In his re-examination of the biogenetic law he came to the conclusion that "the only functionless ancestral structures, which are present in development, are those which at some time or another have been of use to the organism during its development after they have ceased to be so in the adult." The length of time in such cases since the disuse of such an organ in the young is much shorter than that since its use in the adult. All organs functionless in the adult, but functional in the early ontogeny, develop in the normal way. Organs no longer functional at any time dwindle all along the line of development. In *Typhlogobius*, where the eye is functional in the young, it develops to full size in the embryo and it is not till late in life that degeneration is noticeable. In *Amblyopsis* on the other hand, where the eye has not been functional at any period of ontogeny for many generations where the eye of both the young and adult lost their function on entering the caves, and where degeneration begins at an early period and continues till death, the degenerate condition has reached the early stages of the embryo. It is only during the first few hours that the eye gives promise of becoming anything more than it eventually does become. The degree of degeneration of an organ can be measured as readily by the stage in ontogeny when the degeneration becomes noticeable as by the structure in the adult. The greater the degeneration the further back in the ontogeny the degenerate condition becomes apparent unless, as stated above, the organ is of use at some time in ontogeny. It is evident that an organ in the process of being perfected by



1. Part of the section of the head of *Chologaster papilliferus* at the optic nerve; subo.-suborbital.

2. Part of the section of the head of *Chologaster agassizii*.

3. Part of the section of the head of an *Amblyopsis* showing the location of the eye; subo.-suborbital. scl., scleral-cartilage.

4. Part of the section of the head of *Troglichthys* passing through the eye; al. ep., alimentary epithelium.

5. The most degenerate vertebrate eye known, that of *Troglichthys* in vertical section. 1, pigment layer of the retina; 3–7, retina from the pigmented layer to the inner reticular layer; 8, inner reticular layer; 9, ganglionic layer; n. op., optic nerve; nl. l., nuclei of the hyaloid; chr. choroid pigment; scl. c., scleral cartilages.

selection may be crowded into the early stages of ontogeny by post selection. Evidently the degenerate condition is not crowded back for the same reason. How it is crowded back I am unable to say. A satisfactory explanation of this will also be a satisfactory explanation of the process by which individually acquired characteristics are enabled to appear in the next generation. The facts, which are patent, have been formulated by Hyatt in his law of tachygenesis.

Cessation of development takes place only in so far as the number of cells are concerned. The number of cell generations produced, being continually smaller, result in an organ as a consequence also smaller. In this sense we have a cessation of development (cell division, not morphogenic development) in ever earlier stages. That there is an actual retardation of development is evident from *Amblyopsis* and *Typhlichthys* in which the eye has not reached its final form when the fish are 25 mm. long.

Histogenic development is a prolonged process and ontogenic degeneration is still operative at least in *Amblyopsis*.

Degeneration in the individual is not the result of the ingrowth of connective tissue cells as far as I can determine. It is rather a process of starving, or shriveling and resorption of parts.

From the foregoing it is evident that degeneration has not proceeded in the reverse order of development, rather the older normal stages of ontogenic development have been modified into the more recent phyletic stages through which the eye has passed. The adult degenerate eye is not an arrested ontogenic stage of development but a new adaptation and there is an attempt in ontogeny to reach the degenerate adult condition in the most direct way possible.

CARL H. EIGENMANN.

SCIENTIFIC BOOKS.

The Ore Deposits of the United States and Canada. By JAMES FURMAN KEMP. Third Edition entirely rewritten and enlarged. New York and London, The Scientific Publishing Company. 1900.

The first edition of 'Kemp's Ore Deposits of the United States' appeared in 1893. The second edition from the same plates, in which forty to fifty pages of additional matter had been inserted, was published in 1895. We now have the third edition, with entirely new plates, which forms a volume nearly twice as thick as the first, with larger type, heavier paper and additional plates which contribute, as well as the new matter, to its increased size. As this is practically the only modern work dealing in any adequate fashion with this important subject, and as it hence constitutes the standard work for reference with regard to the ore deposits of the United States and Canada, it is important to consider its shortcomings as well as its merits, and even to dwell upon the former.

It must be evident to all who consult the work that Professor Kemp has been remarkably thorough in his search of the literature of his subject and few books have a more complete bibliography; the references, moreover, are distributed throughout the text, not lumped together at the end, so that it requires very little labor on the part of the reader to go back to original authorities on any given point. Kemp possesses, moreover, in a high degree the important faculty of reading intelligently and of expressing concisely the leading facts gathered in the course of his reading. This is perhaps the most important qualification for a work that is essentially a compilation rather than an original treatise.

For a philosophical treatment of phenomena like ore deposits, in which different observers may in all honesty draw diametrically different conclusions from their respective examinations of the same deposit, it is essential that the author should have been able by personal inspection to verify the relative accuracy or degree of probability of opposing views; for in this case, even if we may differ with the author's theoretical opinions, we know that the coefficient of error, if such we regard it, will be constant through his work.

In the first edition of Kemp's work, there was some evidence of haste in preparation, for which, apparently, the publishers' demand for copy was in a measure responsible. In the later editions, there has been ample time to remedy any shortcomings that may have arisen from this cause, hence it is well to examine with some detail the nature of the changes that have been made in the last edition. The book is divided into two parts; Part II., a description of the deposits of the respective metals, occupying about five-sixths of the total space. In Part I., which deals with general characteristics, there has been added to Chapter I., on the 'Formation of Cavities,' a statement of Van Hise's division of the earth's crust into three zones, one of fracture, one of fracture and flowage combined, and one of flowage alone; also six pages on 'Underground Circulation,' but nothing to the very brief mention of 'Replacement as a mode of deposition.' In Chapter III., on 'Minerals and their source,' there has been added a paragraph on the association of certain metals with certain rocks, and one on secondary migrations of vein materials, with references to De Launay's recently expressed views. In Chapter VI., on the 'Classification of Ore Deposit,' the author has elaborated the discussion of his own system; especially in the direction of magmatic differentiation, relegating the descriptions of other systems to an appendix at the close of the work; the other three chapters are practically unchanged.

It is in the descriptions in Part II. that the most changes have been made, and these have been mainly as insertions of new paragraphs, so that the statement on the title page that the volume has been 'entirely rewritten,' for which the publishers are evidently responsible, is hardly justified. The actual increase in the number of pages is one hundred and eleven, but this is in considerable part due to larger type. It has evidently been considered important to preserve, as far as possible, the same relative numbering of paragraphs in this as in former editions; new matter is largely taken from new publications of Government surveys, and from papers in the transactions of the American Institute of Mining Engineers. The following are the more important changes in order of chapters:

In descriptions of 'Iron Deposits' important enlargements are made from the work of Van Hise and his associates in the Lake Superior region and from the author's studies in the Adirondacks. Under 'Copper Ores' the description of the Ducktown and Butte deposits have been largely rewritten, and those on the 'Lake Superior Deposits' have been elaborated; mention is made of some in Idaho. Additions have been made to the discussions of the Lead and Zinc Deposits of the Mississippi Valley from the reports of Winslow and Jenney; in the chapter on 'Zinc alone,' no change is perceptible. Under 'Lead and Silver' new descriptions are given of the Tenmile, Eagle River and Aspen districts in Colorado (the latter rather inadequate), and under 'Silver and Gold' of the Telluride, Custer County and Cripple Creek districts, in the same State. Under the same head, hitherto unpublished data is given from a paper by J. D. Irving on the Black Hills' Deposits, which, like those of Cripple Creek, are more properly classed under 'Gold alone.' New data as to Montana, Idaho and Utah, are added on the authority of Weed, Lindgren and Spurr, respectively. Descriptions of the 'Gold Deposits of the Pacific Slope' are very largely rewritten from the reports of Lindgren, Becker, Turner and others. Under the heading 'Gold elsewhere in the United States and Canada,' the gold deposits of the Appalachians, which have been barely noticed before, are briefly described, mainly from Becker's report; but of the eight pages of text fully one-half are occupied by references. Eleven pages are given to Alaska and British Columbia, with notes on Nova Scotia. About eighteen paragraphs have been added to the chapter on the 'Lesser Metals' in which those that bear upon the theory of magmatic separation are especially prominent.

The improvement in the illustrations of the volume is most marked, as there were very inferior reproductions in former editions; some of the poorest have been eliminated, and the half-tone prints, both old and new, are of remarkably improved quality, though some still leave much to be desired (*e. g.*, Fig. 122). The new illustrations are largely from Government reports, but many photographs are by individuals, especially by the author. From these it appears that, since the publication of the first edition, the author has himself visited some of the important mining districts of the west, but in many cases it is evident he still does not possess sufficient familiarity with the regions to judge, from published reports of a given mining district, whether or not those of one author possess inherent merits entitling his views to superior consideration over those of another.

Professor Kemp, who is an excellent petrographer, has, as shown by his papers published elsewhere, a decided leaning toward the theory of magmatic separation of ore minerals held by Scandinavian geologists, like them, viewing the subject primarily from a petrographic standpoint. The sufficiency of this method for the formation of ore deposits, unless aided by later concentrations through the agency of circulating waters, is not, however, regarded with so much favor by most mining geologists of wide practical experience in America.

Taken as a whole the book presents an excellent bird's-eye view of the ore deposits of the country, as nearly up to date as is practicable, with a fair-minded presentation of the various views held as to their origin and mode of formation. The mining community is certainly indebted to Professor Kemp for the ability and thoroughness with which he has accomplished his laborious task, the magnitude of which few beside the author can adequately appreciate.

S. F. EMMONS.

The Nature and Work of Plants. An Introduction to the Study of Botany. By DANIEL TREMBLY MACDOUGAL, Ph.D., Director of the Laboratories, New York Botanical Garden. New York, The Macmillan Company. 1900. Pp. xviii + 218. 12mo.

The author's introductory paragraph gives us his point of view. "The course outlined in this little book is essentially a study of the functions or action of the plant, and organs are considered chiefly as instruments for the performance of work, with but little attention to their morphology. It is believed that this method of introduction to the subject of botany will be best suited for beginners who have not at hand the facilities of a laboratory. In conformity with this idea, the use of technical terms has been restricted to the actual necessities of logical treatment, and the demonstrations have been developed by the simplest experimental methods."

He takes up the subject in ten chapters, as follows: I. the composition and purposes of plants: II. the material of which plants are made up; III. the manner in which different kinds of work are divided among the members of the body; IV. the roots; V. the leaves; VI. stems; VII. the way in which new plants arise; VIII. seeds and fruits; IX. the power or energy of the plant; X. relations of plants to each other, and the place in which they live. These chapters include two hundred and fifty paragraphs, each of which directs attention to a single fact or group of facts, which in most cases may be subjected to observation or experiment by the pupil. Very simple suggestions are given for these observations and experiments, and the pupil is usually left quite free to use his own ingenuity in carrying them out. While function is emphasized, structure is not ignored, but this is almost entirely confined to gross structure, the author's intention being to require no greater aid to the naked eye than a hand lens magnifying from six to ten diameters.

The book is non-technical, in conformity to the trend of recent text-books, and is remarkable in having *no illustrations whatever*, the author depending upon the simplicity and clearness of his text and the plant or experiment itself to furnish ideas to the pupil. Whether the pupils and teachers who have been brought to expect fine 'half-tone' illustrations of everything from cell elements to plant communities, and a profusion of diagrams of physiological apparatus, with 'half-tones' showing the results of experiments, will take kindly to this book which implies and demands *work* on the part of both, remains to be seen. There is a good deal of laziness in the world, and we fear that the temptation to use a book with pictures (which too often are studied in lieu of the experiments) may be so strong as to prevent the general use of Dr. MacDougal's book.

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De praktische toepassing van Stoomschuif- en Schaarbewegingen bij Stationaire, Locomobiel-, Locomotief- en Scheeps-machines door C. STEUERWALD; Mit eene voorede van H. A. RAVENEK. By W. S. AUCHINCLOSS. Leiden. A. W. Sijthoff. 1899. Pp. 108. Many illustrations.

This book is a translation, into the Dutch, of Auchincloss' well-known treatise on valve-motion, of which a German version has long been in type. The translator is a member of the Faculty of the Polytechnic School of Delft; the introduction is written by Professor Ravenek of the same institution. There is no lack of such works in the English, German and French languages; but the work of Auchincloss excels in the simple and very clear manner in which the graphical constructions are made, "without preceding calculations, simply by outlines on the drawing-board," as Professor Ravenek says in his introduction. The treatise is adjudged 'very suitable to be placed in the hands of apprentices and draughtsmen' as well as of students in mechanical engineering.

The British measures of the original are replaced in the translation by metric.

This reproduction of the American work in Dutch is one of the most gratifying testimonials to the value of the work which has yet appeared. The book is unusually well-printed and its illustrations are exceptionally well-made.

R. H. T.

Mesure des température élevées. Par. H. LE CHATELIER et O. BOUDOUARD. Paris, G. Carré et C. Naud. 1900. Pp. 1–220.

In these few pages Le Chatelier and his assistant have given a terse and useful account of the principal methods of cotemporaneous pyrometry. Measurement of high temperature has, as a rule, referred to the comparison of different temperature functions, and the results obtained have therefore differed enormously. The confusion has gradually subsided however, in proportion as the air thermometry of high temperatures has been more fully mastered. Le Chatelier makes a judicious selection of standard temperatures in the introductory chapters of his book and estimates the probable error to be 1° between 200° and 500°, 5° between 500° and 800°, 10° between 800° and 1100° and upwards 50° above 1100°. In the list of pyrometers which follows I should have referred the calorimetric pyrometer to Pouillet and perhaps included the viscosity pyrometer.

The brief account given of normal temperatures as defined by Kelvin and their relation to the air thermometer is intelligible, well digested and practical in character, though these corrections at high temperatures are of small moment. An account is also given of the standard (hydrogen) air thermometer of the Bureau International at Sèvres, which may be taken as a preliminary model, since the normal air thermometer for high temperatures has not yet been constructed. The authors might have added that very definite steps are being taken in this direction by Holborn and Day at the Reichsanstalt. It has been shown that the platinum-iridium alloy is impervious to nitrogen rigid up to the highest industrial temperatures. Nothing now stands in the way to prevent high temperature measurements from attaining the full precision of low temperature measurements.

The errors usually encountered in high temperature thermometry make up Chapter III. of the book, after which various historical pyrometers are described from figures, and critically discussed. It is interesting to note that the errors of Pouillet were largely due to the high value of the coefficient of expansion then in vogue. Among the whole series the interferential pyrometer of D. Berthelot may be singled out as being peculiarly promising, both on account of the simple and apparently correct principle on which it is based, and on account of its indefinitely high temperature limit of application.

In preference to platinum which is expensive and iron which behaves anomalously, nickel has been recently proposed for calorimetric pyrometry. The authors give a series of appropriate data, and figures of available apparatus, together with the probable inaccuracies of this somewhat unsatisfactory method of pyrometry. Incidentally it may be appropriate (as for instance in the case of Violle's famous experiments) but it now has little general laboratory value.

The resistance pyrometer, introduced by Siemans and perfected by Callendar and Griffiths, is for shorter ranges of high temperature (0°–1000°) now without a rival in accuracy. It has the additional advantage of continuous registry almost as far down as the absolute zero of temperature. Calibrated with reference to Callendar's equations by aid of the specially determined boiling point of sulphur (an error was detected in Regnault's value by this very instrument), it is also a convenient instrument in practice.

The chapter on thermoelectric pyrometry, in which Le Chatelier is specially interested is naturally very full, at least in relation to the D'Arsonval method of measurement. This is obviously the more practical though the zero methods give a permanent record. Figures are abundantly inserted of the galvanometers, furnaces, crucibles, and the other necessary paraphernalia of the pyrometric laboratory.

The chapter on radiation pyrometry is antiquated and meagre, inasmuch as nothing is said about the remarkable results of Wien, Lummer, Kurlbaum, not to mention Planck and others who are remodeling the whole subject. So also the mention made of the bolometer is altogether inadequate. On the other hand Le Chatelier enters at length into photometric radiation pyrometry which is of secondary interest by comparison.

The final chapters contain interesting information on Wedgewood pyrometry and on Seeger cones, recipes being given in detail. The book closes with the remarkable work which Roberts-Austen is now doing with his self-registering pyrometer and the new differential method of observation.

The book as a whole is obviously an outgrowth of the laboratory and is supplemented by personal observation. As such it needs no further recommendation.

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SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

THE 99th regular meeting was held at the Cosmos Club, March 14, 1900.

Under informal communications, Mr. J. A. Taff exhibited some asphalts from Indian Territory, and briefly described their occurrence.

On the regular program the following papers were presented:

(1) 'Glacial Sculpture in the Bighorn Mountains,' by Mr. F. E. Matthes.

The glacial cirques on the Bighorn Range are exceptionally well preserved and complete in outline. The crests and spurs separating them have remained unglaciated, and are remnants of pre-glacial topography. The cirques do not necessarily develop at the heads of the pre-glacial alpine valleys. In numerous cases the upper ends of the latter have remained unglaciated while cirques have formed lower down. This raises the question: What are the conditions necessary for the formation of a cirque; or, since a cirque is essentially the product of frost-action in the bergschrund, what determines the location of the bergschrund?

It was shown that the unglaciated areas above the bergschrunds were covered by *quiescent névé* during the period of glaciation. They were *nivated.* The effects of *nivation* are the accentuation of abrupt slopes and the effacing of the pre-glacial drainage lines by deposits of powdered rock produced by frost-fracturing along the edges of the névé sheets. The bergschrunds constitute the boundary between the *nivated* and *glaciated* areas.

According to the evidences gathered in the Bighorn Mountains the location of the boundary line is intimately connected with the depth of the valleys, or, more strictly, with the depth of the névé. That the spheroid of the mean annual temperature of 32° F. does not influence its location is demonstrated by the fact that cirques and nivated areas exist side by side at all elevations from 10,000 feet up to 13,000 feet.

The conclusion is that névé may remain stationary or acquire motion at any of these elevations, regardless of the altitude of the spheroid of 32° F. The only factor which determines whether a body of névé shall have motion or not is its depth.

(2) 'Physiography of the Arkansas Valley Region,' by Mr. Geo. I. Adams.

This is essentially a gradation plain, below which lie the present stream valleys, and above which rise numerous residual hills, ridges, mesas and mountains, to elevations usually not greater than 200 feet. The mountains which occupy the broader synclines, however, may rise from 1500 to 2300 feet above sea-level. The rocks have been thrown into open folds, with east and west trend. There is little faulting. The northern limit of the region is the Boston Mountains, having a monoclinal structure and forming the southern edge of the Ozark Plateau. To the south it is limited by the closely folded and faulted structure of the Ouachita Mountains.

The Arkansas Valley Region may be considered as an extension of the Prairie Plains eastward through the mountains of Indian Territory and Arkansas to the Gulf Plains. It shows evidence of an earlier erosion period in which the streams flowed at relatively higher levels. It may be compared with the Appalachian Valley region in its structural and physiographical relations.

F. L. Ransome,
David White,
Secretaries.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 320th meeting, held on Saturday, March 10th, was devoted to an address by Dean C. Worcester on 'The Birds and Mammals of the Philippines' which was illustrated by lantern slides. The speaker dwelt particularly upon the distribution of the birds, showing the part played by deep straits as barriers to migration between the islands, and stating that the Bornean aspect of the fauna was confined to Palawan and the adjacent small islands. The difficulties of collecting in the Philippines were described, but it was pointed out that these islands offer exceptional opportunities for the zoologist and that a careful study of the fauna might be expected to throw much light on the problems of specific and individual variation.

F. A. Lucas.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

The regular meeting of the Section was held on Friday, February 23d. The first paper of the evening, entited 'Symbolism of the Huichol Indians,' was presented by Carl Lumholtz. The Huichols are a small tribe of about 4000 souls living in the southwestern part of Mexico, on a spur of the Sierra Madre. Their country being difficult of access, they have been left comparatively untouched by civilization, and thus preserved their ancient beliefs and customs intact to the present day. The paraphernalia of the warrior of ancient times, *i. e.*, of the gods of the present race, furnish the principal symbolic objects by which prayers are expressed, and the most important of these articles is the ceremonial arrow left as a sacrificial offering in the temples and considered a carrier of prayers. It is painted and otherwise decorated with symbolic emblems, and attached to it are representations of other paraphernalia of the warrior, as the front-shield and the back-shield, the latter being also viewed as the mat or bed of the god. Frequently the object of the prayer is incorporated in an attachment to the arrow. The vivid imagination of the people makes them see analogies in the most heterogeneous phenomena. They see serpents in the sky, the clouds moving through space, the wind sweeping over the fields, the rain falling down, even in their girdles and ribbons. Certain insects which appear during the wet season are identical with corn, and corn is identical with hikuli, and hikuli identical with deer. The same tendency to consider heterogeneous objects as identical may be observed in the fact that a great variety of objects are considered as plumes. Clouds, cotton-wool, the white tail of the deer, the deer's antlers, and even the deer itself are plumes, and the serpents are believed to have plumes. Naturally, much ambiguity is found, and there are few symbols that express always the same meaning; nor is an idea always expressed by the same symbol. Although this gives a certain individuality to the symbolic objects, we can always trace the connection between the thought to be expressed and the symbol expressing it. The second paper on 'Symbolism of the Arapahoe Indians' was read by A. L. Kroeber. It was shown with the aid of lantern slides that the decorative art of the Arapahoe Indians is throughout realistic (*i. e.*, pictorial) or symbolic.

Geometric patterns occur, but rarely, and the general character of the art is suggestive rather of pictography. Symbols representing animal life, physical nature, and abstract ideas predominate.

Dr. Franz Boas presented a paper on 'The Growth of Children.' A series of measurements of children repeated at annual intervals proves that the variations of growth must be interpreted as mainly due to acceleration and retardation of growth, combined with hereditary influences, which determine the amount of annual growth. It was shown that it is possible to determine the essential elements which determine the amount of annual growth by admission of regulated measurements. These result in a determination of (1) the relation between final development and development at any given period; (2) the typical development at a given period; and (3) the variability of the series in regard to period.

CHARLES H. JUDD,
Secretary.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO.

AT the meeting of January 10th, Mr. R. H. Johnson presented a paper prepared in collaboration with Mr. R. W. Hall, entitled 'Variation in *Palaemonetes* correlated with Salinity.' After calling attention to the fact that our marine species of *Palaemonetes* differ from the fresh-water form in presenting a greater number of rostral teeth, Mr. Johnson stated that various lots of the marine species which were collected in brackish water show an intermediate condition as regards the rostral teeth. A complete series of intermediate forms exists and the natural inference is that the different degrees of salinity cause the observed differences in form. The experiment of rearing the animals in media of different degrees of salinity has not yet been made by the authors, but will be attempted, as this alone will afford complete evidence in regard to the matter.

The second paper of the meeting was a review by Mr. A. N. Young of several recent papers, by Edmond Bordage, on regeneration in insects.

The second meeting of the month was held on January 31st. The first paper of the session 'A Review of Bresslau's paper on the Develment of the Rhabdocoels,' was presented by Mr. E. H. Harper.

The remainder of the session was occupied by an exhibition of a very interesting series of the extremely variable land snail *Pyramidula strigosa* Gould, collected by Hemphill from the Great Basin, a loan from the Powell Museum of the Illinois Wesleyan University through the kindness of Professor J. C. Hartzell. Attention was called to the direction taken by some of the variations. The recorded localities seem to indicate that some of the varieties are quite local in their distribution and that there is distinct geographical isolation. It was suggested that the history of the topography might throw light upon this isolation. Gilbert's map of 'Lake Bonneville' shows that the Oquirrh Mountains (the locality for the *Oquirrhensis* and *Utahensis*) were then situated upon a narrow peninsula. Climate may have since aided in preserving this isolation. This species is of special interest to students of evolution and well deserves to be better and more widely known.

C. M. CHILD.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis on the evening of February 19, 1900, 43 persons were present. Professor Patrick Geddes, of University College, Dundee, in an address of about an hour, traced the increasingly complex relation of the world to science and the rapidly increasing need of co-ordination of the sciences, and then gave a concise account of the purposes which it is hoped to realize and the methods to be adopted by the International Association for the Advancement of Science, Art and Education, which grew out of the meetings of the British and French Associations for the Advancement of Science last autumn, and is to hold its first international assembly at the Paris Exposition in the course of the present year, the purpose of the Association, recognizing the wealth of instructive material brought together by the great transient museums, the World's Fairs, being the fullest possible utilization of the educational facilities so brought together.

On the conclusion of Professor Geddes' address, Hon. D. R. Francis, on the call of the President, spoke briefly on the subject presented by Professor Geddes, expressing a warm interest in the work of the Association, the coöperation of which with the Louisiana Purchase Exposition being planned for St. Louis, a few years hence, is hoped for.

A paper by Dr. G. A. Miller, 'On the primitive substitution groups of degree ten,' was presented by title.

Professor J. L. Van Ornum, late of the United States Engineer Corps, spoke interestingly on 'The sanitary cleaning of a city, as exemplified by Cienfuegos, Cuba,' explaining the conditions found by the United States Army on taking possession of that city, and the thoroughness with which the streets, court yards and cesspools were cleansed by the Engineer Corps, which also charged itself with the betterment of the city water supply. A diagram which the speaker had prepared showed that in addition to a very marked lowering of the death rate which attended the supply of an abundance of wholesome food, on the occupation of Cienfuegos, there had been a decrease of considerably over fifty per cent. in the weekly death rate, directly attributable to the sanitary cleansing of the city; and he further stated that since this work had been done, yellow fever, which before that time had been endemic in Cienfuegos, had been absent from the city.

Five persons were elected to active membership in the Academy.

William Trelease,
Recording Secretary.

DISCUSSION AND CORRESPONDENCE.

'FLOATING SAND.' 'FLOATING STONES.'

In the *American Geologist* for January, 1896 (Vol. XVII, pp. 29–37) I published an article on 'Floating Sand: an Unusual Mode of River Transportation' in which I gave a detailed account of that phenomenon as seen by me during the preceding August on the Llano river, a tributary of the Colorado, at Bessemer, a station on the Austin and Northwestern Railroad, 94 miles from Austin, Texas. I further gave an account of numerous experiments performed for the purpose of ascertaining how sand may be floated, what sand will float, and why sand will float. No less than fourteen different sands were examined some of which were from widely separated localities, as, for instance, the coast of Long Island and that of Lake Michigan, at Chicago; from the friable sandstone at Alum Bay, Isle of Wight, and the Lower Carboniferous at Pea Ridge, Arkansas. At the time of writing, I may add, the only account of floating sand known to me was in a brief article 'On a Peculiar Method of Sand-Transportation by Rivers' published by Mr. James C. Graham in the *American Journal of Science*, III, Vol. XL, p. 470 (December, 1890) and this I had failed to notice until I had begun my investigations.

Without going into the details of my paper further at this point, I will enumerate the conclusions reached which were as follows:

"1. That sand grains will float in perfectly still water for an indefinite time.

"2. That the grains which float are not necessarily siliceous. That flakes of mica, fragments of marble, bituminous shale, etc., also float and that some of them, the marble and the bituminous shale, for example, are unusually buoyant.

"3. That the property of floating is not confined to the sand of any particular locality, but depends to a considerable extent upon the angularity, *i. e.*, the shape of the grains.

"4. That whether sand will float or not depends, also, upon the mode of launching. Whether it be by ripple waves, as stated by Mr. Graham, or by undermining, it must be gently done, for should the grains be plunged into the water with sufficient force to completely immerse them they will immediately sink.

"5. That the natural conditions necessary to the floating of sand in rivers are somewhat unusual, depending, in the case of the Llano, upon a flood without local rains and, in that of the Connecticut, upon the manner in which certain waves strike a sand-bar. It is quite possible, however, that floating sand is much more common than is ordinarily supposed.

"6. That the physical explanation of the problem is complex rather than simple, and at best unsatisfactory in several important particulars, and that with the advance of molecular physics we may hope for a better understanding of what we now, for convenience, term 'superficial viscosity' and 'capillary attraction.'"

This article attracted considerable attention and was reprinted entire or in part in other journals.

Among the letters received at the time of publication, the following substantiate the last part of the 5th conclusion, viz, that floating sand is much more common than is ordinarily supposed:

Professor William Morris Davis wrote, January 28, 1896: "I have noticed the same thing (floating sand) on the tidal currents of Cape Cod."

Mr. Henry W. Nichols of Field Columbian Museum, Chicago, wrote, February 3, 1896:

"I would like to add another instance. At Cohasset, Mass., a town about twenty-five miles south of Boston, there is a land locked inlet from the sea, known as Little Harbor. There are here and there along its shores, small beaches of angular gravel and sand. When there is no wind, the tide rises gently on these beaches without even a ripple, and gently lifts grains of dry sand which form such patches as you describe a foot or more in diameter. Some days such floating patches are very numerous, and may be seen going out with the tide all the way from the head of the Harbor to the outlet over a mile distant. The rock of the region is granite and the sand is probably derived from it. The grains are very angular. Without thinking much upon the subject, I have always considered that a film of air adhered to the grains and kept them from wetting, and that the floating was due to surface tension as in the case of the familiar experiment with a needle."

In the *American Geologist* for November, 1898, Professor George E. Ladd discussed the 'Geological Phenomena resulting from the Surface Tension of Water.' Under the caption 'Floating Materials' (p. 283) he says:

"It is not uncommon to see materials of a higher specific gravity than water floating upon its surface.

"The principle involved is again that of surface tension, and substances thus float only when the attraction for the water is less than the latter's surface tension.

"The geological results of this principle are chiefly the floating and shifting from place to place of sands. While I have observed such an occurrence on many occasions, in different places, the most important noticed was in Massachusetts, at the mouth of the Merrimac River. Here the northern end of Plum Island, which is a vast accumulation of sand, shuts in the harbor of Newburyport on the southeastern side. The action of the winds, of the waves, in time of storm, and the shifting currents (the position of the harbor's channel varying rapidly) result in the formation of numerous bays or 'basins' in the sandy island, on the protected side, often occupying extensive areas. The largest of these, having a circumference of something over a mile, has endured for the past forty or fifty years. The sand consists mainly of coarse, sharply angular quartz, but much feldspar is present, some mica, and numerous fragments of schistose and gneissic rocks. Whenever, on the retreat of the tide, the beaches and the exposed bars are dried by the sun's heat, the returning water, if not too greatly disturbed by unfavorable winds, lifts, as it creeps up the slope, the whole superficial film of sand, including large thin pebbles of schist, and floats it gently on the surface. The surface of the water, near the shores bearing the sand, commonly moves out towards the main river, even when the tide is rising, the incoming water flowing beneath.

"I have estimated that in the course of a year something like a thousand tons of sand, at a minimum, are lifted and borne away to new resting places by the floating power of surface tension at this locality alone."

During the present year Dr. Erland Nordenskiold's communication to *Nature* (January 18, 1900, p. 278) on 'Floating Stones,' seen by him during his recent visit to southwest Patagonia, has evidently been read with great interest in England and has been the means of calling forth a number of statements concerning floating sand and other mineral matter, such as fragments of shells. Neither Dr. Nordenskiold nor the other correspondents seem to have been aware of the papers published on that subject by Messrs. Graham, Ladd and myself, though printed in journals of wide reputation and extended circulation. Dr. Nordenskiold says:

"Whilst rowing in the long and narrow channel of Ultima Esperansa, to study the plankton, we observed, when the sea was calm or only agitated by a slight swell, small fragments of slate which floated upon the surface packed together in larger or smaller clusters. They drove hither and thither in the neighborhood of the shore, until they were driven away by the strong current which at intervals swept forward in the channel. The quantity was considerable; for instance, 700 of them were obtained at one cast of the net in a few minutes. The stones had evidently drifted out from the beach, which consisted mainly of similiar stone fragments washed off from the cliffs composed of a bituminous mesozoic slate. The surface of the stones was dry, and they sunk immediately when it became wet by touching or by the movement of the swell.

"The slate fragments collected on the sea surface had a specific gravity of 2.71. The specific gravity of the water in the channel was only 1.0049 at a temperature of 15° C. (59° F.). The largest stone which I obtained from the surface weighed 0.8 gram. Twenty of the smaller fragments had a mean weight of 0.3 gram. The fragments contained no air cavities perceptible to the unaided eye."

These stones, which are pictured in *Nature*, are, it must be confessed, extraordinarily large. The specific gravity of the Llano sand was 2.59 and the largest grains could not approach the stones above mentioned in size.

To quote further from Nordenskiold:

"On examining the floating stones one could discern small gaseous bubbles attached to the under surface of them, and at the shore stones can be seen on the very fringe of the beach which are just beginning to float lightened by gaseous bubbles."

In my paper (p. 31) a possible explanation is offered for the presence of the 'gaseous bubbles': In one of my experiments I dug several holes in the sand forming a bank in the bed of the Llano and when their sides caved in, the dry grains forming the outer coat of the deposit, were gently launched and floated much more abundantly than in a previous experiment when the surface was damp. Furthermore, as each mass of sand slipped into the water, and exclusive of the floating grains, sunk, *the air contained in the interstices between the particles rose to the surface forming a patch of foam or froth.*

Again Dr. Nordenskiold remarks:

"It is probable that the stones were not only provided with gas bubbles, which can be perceived by the eye, but that they were surrounded by an envelope of gas supported by an insignificant coating of algæ, of which the stones are surrounded. At least, traces of diatoms and algæ are discernible on the stones after drying. The greasy surface of the mineral of which the stones consisted also prevented the water from adhering to them, and caused the stones to be surrounded with a concave meniscus, which naturally may have contributed to, and perhaps was the main cause of their floating, which sometimes was further facilitated by a patelliform shape of some of the bigger stones."

The floating sand of the Llano showed upon careful examination no signs of the presence of low forms of vegetable growth, neither was it in the least greasy. That the presence of oil in a bituminous shale may facilitate its floating property can scarcely be doubted.

Nature for February 1, 1900 (p. 318), contains two communications upon 'Floating Stones' by Messrs. Cecil Carus-Wilson and R. C. T. Evans, respectively.

Most of the points made by Mr. Carus-Wilson are covered in the papers of Messrs. Graham, Ladd and myself. It may, however, be of interest here to call attention to the following. He says:

"The grains float as patches composed of fine and coarse material clinging together; the presence of the very fine grains appears to facilitate the flotation of the larger grains and shells."

As bearing on this statement I will quote briefly from my paper:

"As I was sprinkling some sand upon the river for experimental purposes, a pebble almost as large as the end of my little finger fell into the center of a floating patch, which, to my great astonishment and delight, was depressed, like a funnel, for, say, half an inch before the cause of this unexpected phenomenon broke through its surface and sunk to the bottom" (p. 35).

His statement regarding the formation of 'patches' had also been anticipated in my paper (p. 36).

Mr. Evans writes that he has observed the phenomenon of floating stones at Kimmeridge, where the flaky nature of the beach material renders their appearance very common.

In experimenting with broken roofing slate he found that a small dried piece $1.5 \times .75$ cms. by about 1 cm. floats easily on water when gently placed on the surface.

It will be seen from the above statements that all observers agree that to float, the sand or stones must be lightly launched without complete wetting.

Frederic W. Simonds.
University of Texas.

SEA-BIRDS A SANITARY NECESSITY.

This country is on the verge of losing forever one of the main features of its seacoast charms—the sea-birds themselves. In fact, the Terns, the most exquisite of the Gull family, which formerly thronged our whole coast, have been so nearly wiped out by agents of the milliners that this year's onslaught, already fully organized, will glean almost the last pair from the few small breeding colonies which remain, wherever these are unprotected. And the larger Gulls, which are not only very beautiful, but absolutely essential as harbor scavengers, are also being decimated for the same purpose.

All these species, with their exquisite beauty, their wild voices and their most romantic lives, peopling a realm which, without them, would be oppressive in its dreary grandeur, will reach their breeding places in a few weeks, and the Terns, especially, are liable to be slaughtered the moment they get there; therefore the promptest action is necessary, if we are to save even the few pairs of the latter which could restock our devasted coast when the evil eye of fashion shall have turned to other victims.

Simple economic considerations make it a matter of course that the Gulls *must* be saved. An immense horde of them, which naturalists think number anywhere from a hundred thousand to a million, gorge twice a day in New York Bay upon garbage. As the hour of the 'dump' approaches, their multitudes fill the whole air to an immense height, over an area of several miles, then gradually settle on the sea in vast white sheets. The whistle of the police boat, the signal to 'dump,' seems to waft them simultaneously into the air, to gather, like dense snow clouds, over the floating masses just emptied from the many scows.

Imagine from what an amount of putrid matter these birds, as big as hens, save the adjacent beaches, not to speak of their perpetual gleaning in the actual harbors! And this is a specimen of what occurs at every port. And shall this incalculable sanitary benefit, and all this beauty, terminate forever, and for no worthy purpose?

If money enough can be raised, the Committee of the American Ornithologists' Union will guard every breeding place where there is a law to back them, as Mr. Mackay and Mr. Dutcher have done at Vineyard Sound Islands and Great Gull Island. The utmost caution will be used in choosing wardens, and the Committee will be glad to receive names of men especia ly suited for the post. Light-house keepers and Life-Saving Station captains will be employed wherever feasible. A very encouraging sum is already in the hands of the Committee.

The places to be protected are certain islands on the coast of Maine, Long Island, New Jersey, Maryland, and perhaps Virginia and Florida. In Maine alone there is need of all the money we can possibly get, since there single wardens are afraid to face the rough plumers, and some more elaborate organization is the only hope.

The American Ornithologists' Union therefore appeals to every bird-lover for money to be used in hiring wardens to protect the birds while nesting. Contributions should be sent to Mr. William Dutcher, treasurer of the Union, at 525 Manhattan avenue, New York City, who will furnish all desired information.

ABBOTT H. THAYER, WILLIAM BREWSTER, Pres. Mass. Audubon Society; WITMER STONE, Chairman A. O. U. Com. on Bird Protection; ROBERT RIDGWAY, President A. O. U.; C. HART MERRIAM, Chief U. S. Biological Survey; Vice-Pres. A. O. U.; A. K. FISHER, Ass't. Biologist, U. S. Biological Survey; J. A. ALLEN, Curator Vertebrate Zoology, Am. Mus. Nat. His.; FRANK M. CHAPMAN, Ass't. Curator Ver. Zoology, Am. Mus. Nat. His.; WILLIAM DUTCHER, Treasurer A. O. U.

March 17, 1900.

NOTES ON ELECTRICAL ENGINEERING.

A NEW INDUSTRIAL SITUATION.

IN a pamphlet recently issued by the Westinghouse Companies, Mr. Geo. Westinghouse calls attention to the prospective use of the gas engine on a great scale for the generation of power and, in connection with central gas plants and pipe lines, for the distribution of power. Mr. Westinghouse says that "long familiarity with the electrical industry, the pipe line transportation of natural gas in great quantities, and an active interest in the development of large gas engines, satisfy me that the great economies which will result from the distribution of power by means of gas generated at central points, and conveyed in pipes along the lines of railway for the operation of gas engines and electric generators, will be sufficient to justify the expenditure of the capital necessary for such installations in connection with the electrical equipment of railways, particularly metropolitan and suburban lines. The advantages of the use of gas engines can be best appreciated when it is understood that if a gas company were to supplant the present gas illumination by an equal amount of electric light obtained from gas-driven dynamos, it would have left for sale or other purposes over 60 per cent. of its present gas output."

In a communication to the New York *Times* of January 10, 1900, Mr. Westinghouse suggests the employment of fuel gas and gas engines for supplying light and power to the whole of Manhattan Island. He calls attention to the fact that city garbage is much better adapted for the manufacture of fuel gas than for use under a steam boiler, the large percentage of water in garbage being little or no disadvantage in the manufacture of fuel gas. He mentions the fact that fuel gas manufacture is a smokeless process, and he points out that the water consumption of gas engines may be kept far below that of steam engines. "Bearing on these questions" says Mr. Westinghouse "and of especial importance, are the partially executed plans of the electric power and light corporations, viz, the Metropolitan, Third Avenue and Manhattan Elevated Railways, the New York Gas and Electric Light, Heat and Power Company, and the United Electric Light and Power Company. If their present plans, which are fairly well known to the engineering profession, are carried to completion, each will have one large steam station on the East River between Twenty-ninth street and the Harlem River, with about 75,000 horse-power of engines, boilers, and electric machinery, making an aggregate of 375,000 horse-power, and which may be largely increased when the underground rapid transit railway is completed, and still further when the electric locomotive is used on all steam railways within the city limits.

"If these corporations were to unite in a common plan to provide the electricity needed in their operations by the adoption of the best available methods, the saving to each in capital expenditure would be very great, and the decreased cost of their supply of electricity would make an important addition to their earnings applicable to the payment of dividends; while, most important of all, the citizens of New York would have solved for them the garbage, smoke, and very largely the water questions.

"I believe the contemplated plans of the corporations above named, which can be shown to be based upon an imperfect knowledge of the subject, will stand in the way of vast public interests, and, so believing, I have said to representatives of some of these companies that the near future would demonstrate the projected power stations and systems of electrical distribution incidental to the character of such stations, to be as far from the best as are the old cable systems for the propulsion of cars."

It seems to the present writer that the recent improvements in the gas engine and the consequent commercial possibility of its use on a vast scale in the transmission and generation of power, warrant the title of the pamphlet issued by the Westinghouse companies 'a new industrial situation,' and it is a matter of especial satisfaction that the plan proposed by Mr. Westinghouse for New York City which promises such great benefits to the community, also commends itself to the business interests of the corporations concerned. Mr. Westinghouse's plan is entirely sound, at least the scientific and technical points involved are clear and certain, and it should engage the attention of every public spirited citizen.

WIRELESS TELEGRAPHY.

The Transactions of the American Institute of Electrical Engineers for December, 1899, contains an interesting discussion on wireless telegraphy. Professor R. A. Fessenden, in particular, describes some interesting experiments by himself and Professor Kintner. These two experimenters being unable to use the ordinary coherer as a measuring instrument, devised a small induction galvanometer (originally due to Elihu Thomson) for measuring the intensity of the electrical waves at the receiving station, and this induction galvanometer is said to be more sensitive than the coherer and well adapted as a receiving instrument in practice. Professor Fessenden also gives a good description, based upon the mathematical work of Hertz, J. J. Thomson and Heaviside, of the character of the electrical waves which pass out from the vertical wire at the sending station; he calls attention to the rational basis for Marconi's law, or rather a modification of Marconi's law, that the range of signalling in miles is proportional to the product of the heights of the vertical wires at the sending and receiving stations, and explains why longer distance signalling is possible over water than over land. Those who are interested in this matter will find Professor Fessenden's discussion instructive and interesting.

Long distance wireless telegraphy seems to be now almost within reach, with high sending and receiving wires and with very powerful electrical disturbances at the sending station, very slight improvements in the sending and receiving apparatus will likely carry the range up to a thousand miles or more.

W. S. F.

CURRENT NOTES ON PHYSIOGRAPHY.

IOWAN DRIFT.

CONTINUED studies of the drift of Iowa by members of the State Geological Survey give new details regarding the topographic differences between the three chief drift sheets (Kansan, Iowan and Wisconsin), indicative of their differences of age. Calvin describes the Iowan drift sheet (*Bull. Geol. Soc. Amer.*, x, 1899, 107–120) as forming a broad plain of long, gently sweeping undulations, on which stream erosion has in general done little work; only the main drainage lines, many of which follow sags in the drift that are taken to indicate pre-Iowan valleys of erosion, are well defined; small lateral channels have been eroded only a mile or so from the main valleys. In contrast with this little carved surface, the Kansan sheet, next south, was maturely and deeply eroded before the Iowan sheet was deposited. The Kansan-Iowan interval is thought to have been fifty times the post-Iowan period. About the middle of the latter period is taken as the date of the lobe of Wisconsin drift that enters from Minnesota and overlaps both the Iowan and Kansan sheets. The surface of this lobate area shows even more distinct signs of youth than are found in the Iowan area; undrained depressions are of frequent occurrence on its undulating prairies; oxidation and leaching have hardly begun; stream erosion is insignificant. The value of topographical evidence as indicating geological dates is seldom better illustrated.

The same author described 'a notable ride' from the driftless area of northeastern Iowa to the Iowan drift sheet, where the contrasts of a maturely dissected upland of normal development, and the broad swells and troughs of a till plain are well presented (*Amer. Geol.*, xxiv, 1899, 372–377).

WESTERN AUSTRALIA.

AN account of part of western Australia by Cadell ('Some geological features of the Coast of Western Australia,' *Trans. Edinb. Geol. Soc.*, vii, 1897, 174–182) ascribes the absence of harbors to a recent slight elevation after prolonged denudation. The elevation is indicated by raised beaches, now 10 or 15 feet above sea level, one beach being from 12 to 18 miles wide and reaching 25 miles inland. The beaches lie on a low, flat plain of denudation, monotonous and desolate, sloping imperceptibly to the sea. An inland excursion of seventy miles was chiefly over a perfectly flat surface of granite, clay slate and other rocks, strewn with wind-worn pebbles and relieved by occasional crystalline knobs which rise over its prairie-like expanse. No mention is made of incised valleys; the few water courses of the region, usually with dry beds, seem to lie but little below the general level. The rocks are as a rule deeply weathered; water being commonly found in wells at depths of 45 or 50 feet. The inland termination of the plain is not described. The possibility of accounting for such a plan by subaërial or by marine denudation is recognized, and a preference is expressed for the latter agency in this case (although the deep weathering of the rocks seems to be more accordant with a subaërial history). A comparison is made between this denuded lowland and the flat pavement on which the Cambrian rocks of northwest Scotland rest; it is further suggested that if the Australian plain were scoured by glacial action, it would be transformed to a hummocky surface, resembling the 'rough quarter' of the gneissic uplands of Sutherland (N. Scotland).

MOUNTAINS AND VALLEYS.

Richter of Graz writes on 'Gebirgshebung und Thalbildung' (*Zeitschr. deut. u. österr. Alpenverein*, xxx, 1899, 18–27), re-affirming the modern view that the bold forms of the Alpine summits result from the carving of valleys between them. He calls attention to the rough equality of height among the peaks of the Alps, and discusses the relation of peak height to valley spacing. He points out that in lofty ranges, the valleys must be relatively far apart, in order to allow the intervening mountain to rise to a great height. Before the greater uplift of the Alps, when the relief of the surface was less, streams and valleys were probably more numerous and closer together. As elevation progressed, some streams deepened their valleys faster than others and the side branches of the more active streams tapped the less active streams at many points and practically destroyed them; thus only the stronger streams survived in the deeper valleys. The rapid erosion of cliffs has reduced the mountain sides to a relatively uniform declivity, and the peaks are defined by the intersection of slopes propagated upward from the stream lines. Glacial action is briefly referred to as having produced trough-like channels whose side walls are steeper than the preglacial valley slopes which rise above them.

THE MEUSE IN BELGIUM.

After the Meuse trenches the Ardennes, it turns eastward along the strike of the Carboniferous rocks, receiving the Sambre from the western extension of the same geological belt. On this longitudinal course, streams of considerable length are received from the valleys of the Ardennes on the south, but the divide on the north lies close to the Sambre-Meuse, except at a few points where it locally loops northward. The streams that drain these loops receive a number of barbed headwaters which flow away from the Meuse valley before turning around towards it. The barbed headwaters are explained by Cornet as having once belonged to streams that flowed continuously northward. They have been captured by side streams of the Meuse in consequence of the depth to which its longitudinal valley has been cut (*Ann. Soc. géol. de Belgique*, xxvii, 1899). The beheaded streams, northward of their diverted headwaters, and their special relations to the valleys that they occupy are not described.

W. M. Davis.

NOTES ON INORGANIC CHEMISTRY.

A paper was read by Dr. Orme Masson before the recent Melbourne meeting of the Australasian Association on the use of Iceland spar as a standard in volumetric analysis, and is reprinted in the *Chemical News*. In Masson's method the pure spar in cleavage crystals is weighed in a beaker and then treated with 20 cc. of the acid to be standardized; after the first effervescence is over the whole is heated to boiling for an hour. The now perfectly neutral calcium chlorid is decanted off, the undissolved spar carefully rinsed in the beaker, dried at 110° and weighed. The loss in weight represents exactly the strength of the acid compared with normal, as 20 cc. of normal acid dissolves exactly 1 gramme of calcium carbonate. The method presents the advantages over the usual Iceland spar method, that there is no indicator used and no titrating of excess of acid with alkali—furthermore the crystals are less hygroscopic than the powder. The method has a further advantage over other methods in that few compounds can easily be obtained in so pure a state or of so definite composition as Iceland spar.

In a recent number of the *Bulletin* of the French Chemical Society Professor Moissan has described a definite phosphid of calcium with the formula Ca_3P_2. It may be formed by the reduction of calcium phosphate with carbon in the electrical furnace, or by the direct action of phosphorus vapors on calcium. In the former case it is crystalline, in the latter amorphous; in both a dark red solid. It is decomposed by water with the formation of phosphin, PH_3, in this respect resembling a number of binary compounds of calcium, such as calcium hydrid with evolution of hydrogen, calcium carbid with evolution of acetylene, calcium nitrid with evolution of ammonia. Lebeau has also described recently arsenids and antimonids of calcium which on treatment with water yield respectively arsin AsH_3 and stibin SbH_3.

ANOTHER new compound of considerable interest, N_3I, has been prepared by Professor Hantzsch, of the University of Würzburg, and is described in the last *Berichte*. This is prepared by the action of iodin on the silver salt of hydrazoic acid, AgN_3. Unlike the other iodids of nitrogen which are dark brown, this is almost colorless. It seems to rather resemble the iodid of cyanogen CNI, which is formed in an analogous way, being soluble in water and of an almost intolerable odor. It is, however, very explosive, being even more unstable than the other iodids of nitrogen.

IN a recent number of *Nature*, R. A. Hadfield describes a contribution which his firm has made to the contest of armor plate *vs.* projectile. The latest improvement in the armor plate is that of Krupp, the composition of the steel used affording exceeding toughness and great tensile strength combined with high elastic limit. The surface is hardened by carburization by gas cementation instead of by charcoal, as in Harveyized plates. Against these plates ordinary projectiles are broken to pieces, their striking energy being wasted in breaking themselves instead of in perforating the plate. Hadfield's projectiles however, when used with a slightly higher velocity than the average usually employed, perforate these plates readily. These projectiles are fitted with a soft metal cap, which takes up a part of the energy which would otherwise be used in shattering the projectile.

IN this connection it may be added that the daily press has published a statement from T. A. Edison, Jr., that he has now devised a new armor plate which has a resistance much greater than the Krupp plate, so that for equal strength, the thickness of the plate can be reduced nearly one-half. At the same time the cost of the plate is very materially less than that of the Krupp or even of the Harvey plate.

THE preparation of some nickel bronze alloys is given by Sergius Kern of St. Petersburg, in the *Chemical News*. These alloys are especially prepared for fittings in high pressure marine boilers, and contain 70 per cent. copper, 17½ to 20 per cent. nickel, and the balance zinc. The alloys rust very slightly, have a tensile strength of 26 to 36 tons per square inch, and elongation of 14 to 17 per cent. in 2 inches.

THE discovery of a series of magnesium-aluminum alloys is reported in *Engineering*. When containing 10 per cent. magnesium the alloy resembles zinc, with 15 per cent. brass, and with 20 per cent. bronze. They give good castings and are resistant to the atmosphere, are fairly hard and work as well as brass. The alloys are lighter than aluminum and while possessing no great strength, are of value for many purposes where a light metal like aluminum would be used, if it could be cast and worked successfully. The inventor, Dr. Ludwig Mach has named the alloys magnalium.

J. L. H.

SCIENTIFIC NOTES AND NEWS.

THE French Association for the Advancement of Science meet at Paris from the 2d to the 9th of August, under the presidency of General Sebert.

THE Ways and Means committee of the New York legislature has reported an item of $60,000 for the purchase of the scientific collections and library of the late Professor James Hall, State geologist and paleontologist for over sixty years. Should this report be sanctioned by the Senate and the Governor, the State Museum will acquire an immense collection in invertebrate paleontology, comprised principally of material from the New York formations. The library is the sum total of all the books brought together by Professor Hall during his remarkably long and active career and will make a unique addition to the State Library. It is hoped that no opposition will be manifested to the completion of this purchase.

PROFESSOR DAVID EDWARD HUGHES, the eminent physicist, has left the greater part of his large estate to four London hospitals, which will receive ultimately between $1,500,000 and $2,000,000. As these hospitals have medical schools attached to them, the money will doubtless be used in large measure for educational and scientific work. Professor Hughes also bequeathed $20,000 each to the Royal Society, and the Paris Academy of Sciences, the income to be used for prizes for original discoveries in physical sciences, particularly in electricity and magnetism. He also left $10,000 each to the London Institute of Electrical Engineers and the Paris Société International des Electriciens for scholarships and $5,000 to the Royal Institute for general purposes.

THE Royal Academy of Sciences at Berlin began on March 19th, the celebration of its 200th anniversary. The Academy was founded by Frederick I. in 1700, according to the plans of Leibnitz, who was its first president, but it was not opened until 1711. According to cablegrams to the daily papers, the Academy was addressed by the German Emperor, and among those present were Professors Moissan, De Pranqueville and Cenart, from France; Professors Mahaffy and Ramsay, and Mr. Thomas E. Thorpe, from Great Britain. Ambassador White represented the Smithsonian Institution, and Professor E. J. Wolff, of Harvard University, the American Academy of Arts and Sciences.

IT is said that the litigation over the estate of the late Dr. Thomas W. Evans has been compromised, leaving about $2,000,000 for a Museum and Dental School at Philadelphia.

THE War Department has given orders to have the transport *Hancock* prepared for the use of the new Philippine Commission, which will sail from San Francisco on April 15th. It is of some interest to note that three members of the commission are college professors. Judge Taft, who succeeds President Schurman, of Cornell University, as chairman, is professor and dean in the Law School of the University of Cincinnati.

MR. M. H. SAVILLE, of the American Museum of Natural History, has returned from a very successful trip to Mexico. Archæological explorations at and near the noted ruins of Mitla were prosecuted to such an extent that but little if any archæological work is left to be done there.

SIR WILLIAM MACCORMAC, after having visited Kimberly and Ladysmith in the interest of the sick and wounded, is returning to Great Britain.

MR. W. E. D. SCOTT, curator of the ornithological collections at Princeton University, has sailed for England to study in the British Museum its collections in connection with the monograph he is preparing on the birds brought from Patagonia by Mr. J. B. Hatcher.

MCGILL UNIVERSITY will, on April 30th, confer the degree of LL.D. on Captain Alfred J. Mahon.

THE council of the Iron and Steel Institute, London, has decided to award the Bessemer gold medal to M. Henri de Wendel, of Joeuf, Meurthe-et-Moselle, France. The presentation will take place at the annual meeting to be held in London on May 9th.

THE Smith's Prizes at Cambridge University are awarded to Mr. J. F. Cameron, of Caius College, for an essay 'On molecules considered as electric oscillators,' and to Mr. R. W. H. T. Hudson, of St. John's College, for an essay on 'Ordinary differential equations of the second order and their singular solutions.'

THE Paris Academy of Sciences has elected as corresponding member Dr. Simon Schwendener, professor of botany in the University of Berlin.

The Geographical Society of Paris has awarded its great gold medal to Major Marchand.

THE eminent British meteorologist, Mr. G. J. Symons, F.R.S., died at London on March 10th, at the age of 62 years.

PROFESSOR THOMAS PRESTON, F.R.S., died at Dublin on March 7th, at the age of 40 years. He had been since 1891 professor of natural philosophy in University College, Dublin, and was also science and art inspector for Ireland. He was the author of well-known works on 'Light' and 'Heat.'

ADMIRAL SIR HENRY FAIRFAX, K.C.B., died at Naples on March 20th, at the age of 63 years. Admiral Fairfax had made two voyages to the Arctic regions in the interests of science.

THE deaths are announced of Professor Georg Rümker, director of the Hamburg Observatory, at the age of 68 years, and of Dr. C. T. R. Luther, director of the Düsseldorf Observatory.

MR. ANDREW BOLTER, of Chicago, died on

March 18th, aged 80 years. He possessed one of the finest entomological collections in the United States.

A Princeton expedition is busily engaged in preparations for the eclipse of May 28th and will probably leave for Wadesboro', North Carolina, ten or twelve days before the eclipse, that place having been selected, because it is the most easily accessible of the stations where the weather probabilities are equally good. The party will probably consist of Professors Young, Brackett, Magie and Reed, Mr. McClenahan, Mr. Russell and Mr. Fisher, with perhaps one or two others. The work undertaken will be mainly spectroscopic, including particularly a determination, both photographic and visual of the position of the Corona-line. A set of photographs of the Corona will also be taken, and careful visual observations will be made upon the relations between the Corona and the solar provinces.

Mr. William H. Crocker has offered to defray the expense of sending a party from the Lick Observatory to observe the total eclipse of the sun on May 28th. The party will be headed by Professors W. W. Campbell and C. D. Perine. A station has not as yet been definitely chosen, but it will probably be at Barnesville near Atlanta.

It was announced at a meeting of the Royal Scottish Geographical Society, on March 2d, that a Scottish expedition was to be organized to co-operate with the English and German Antarctic expeditions. The Weddell Sea quadrant south of the Atlantic Ocean will be the Scottish sphere. The British sphere will be south of the Pacific and the German south of the Indian Ocean. William S. Bruce will lead the Scottish expedition.

The appointment of a receiver for the firm of D. Appleton & Co. will be regretted by all men of science. By the publication of the *Popular Science Monthly*, the *International Scientific Series* and many other important scientific works, the firm has done much for the advancement of science.

Professor Patrick Geddes has been making addresses in the United States with a view to arousing interest in the International Association for the Advancement of Science, Arts, and Education, which will hold a first assembly at Paris during the Exposition. We have already called attention to the establishment of the Association which dates from the recent meeting of the British and French Associations at Dover and Bologne. M. Bourgeois is general president of the Association, and the vice-presidents of the French group are M. Gréard, rector of the University of Paris and M. Brouardel, last year president of the French Association. The vice-presidents of the English group are Dr. James Bryce and Sir Archibald Geikie. The secretary is Professor Patrick Geddes. The object of the assembly at Paris appears to be chiefly social and a guide to the Paris Exposition and its congresses. Headquarters will be established and information by lectures and otherwise in regard to the congresses, the exposition and the educational advantages of Paris will be provided. The membership fee is $5.00.

A joint resolution has been introduced in Congress authorizing the publication of fifteen thousand copies of the general report of the expedition of the steamer *Fishhawk* to Puerto Rico, including the chapter relating to the fish and fisheries of Puerto Rico, as contained in the 'Fish Commission Bulletin' for 1900; nine thousand for the use of the House, three thousand for the use of the Senate, and three thousand for the use of the United States Fish Commission.

Governor Roosevelt of New York and Governor Vorhees of New Jersey have signed bills providing for the appointment of commissions to protect the Palisades. The commissions have power to condemn land containing the steep rocks, but it does not appear that New Jersey has made any appropriation for the purchase of the land.

Baron von Lipperheide has presented to the Prussian State his collection of works on costume. It contains over 10,000 volumes and about 20,000 separate plates, being the most complete collection in the world. The history of industries, etc., are in large measure represented and the collection is thus of considerable anthropological interest.

Another attempt to create an artificial universal language has been published by Dr. Ad. Nicolas of La Bour boule, in the Memoirs of the National Society of Agriculture of Angers. This newest language is called *Spokil.* The author's object is to "combiner l'euphoine, la mnemotechnie, l'analogie, l'étymologie, l'idéographie." The following are eight consecutive roots: "Eibo, pocher; Eigm, mucilages, Eign, charbon; Eivl, bourre; Eivr, filament; Eipl, elements ligneux; Eipn, gaz; Eikl, percuteurs." It seems unlikely that 'Spokil' will attain even the temporary vogue of Volapük.

A weekly botanical convention of the botanical workers in New York City, is held at the Museum of the Botanical Garden, on Wednesday afternoons, which is open to all interested persons. Among the subjects which have been presented the following are to be noted: Dwarfs and Nanism in general, by Dr. MacDougal, with an exhibition of dwarf Japanese trees, by Mr. Henshaw; Plants and poisons, by Dr. R. H. True; Spore dissemination in the Sordariaceæ, by Mr. David Griffiths; the Flora of Montana and the Yellowstone Park, by Dr. Rydberg, with an exhibition of new and interesting species from the regions named; and the origin of the leafy sporophyte, by Dr. C. C. Curtis.

In view of the U. S. Treasury decision relative to free importation of philosophical apparatus and preparations, which is likely to affect seriously the work of educational institutions and the laboratories of research, the Council of the American Chemical Society has voted that the president of the Society be authorized and directed to appoint a committee consisting of fifteen members of the Society, who shall be instructed to consider the present status of the laws and regulations governing the free importation of instruments, apparatus and materials used in research work, and to take such action in the premises in the direction of securing such new legislation or modifications of existing laws and regulations as they may find necessary to the interests of the educational and research institutions.

Nature states that letters have been received from Mr. J. E. S. Moore's expedition dated from Ujiji, on Lake Tanganyika, November 12, 1899. The other members of the party had proceeded to the north end of the lake, where Mr. Moore was proposing to join them so soon as the necessary number of porters had been assembled. The expedition had been fairly successful both in collecting zoological specimens from the lake and in studying the geological features of the surrounding district. They had obtained numerous living specimens of the curious forms of mollusca of the lake, besides a good series of fishes and crustaceans. The celebrated jelly-fish (*Limnocnida tanganjicae*) had been met with in great numbers. Mr. Moore had escaped fever altogether, but most of the other members of the party had had a touch of it.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. J. D. Rockefeller has offered to give $100,000 to Wellesley College on condition that the debt of the college of about the same amount be paid by subscription from the alumni.

The Tulane University of Louisiana has received a gift of $50,000 from Mrs. Caroline Tilton to assist in establishing a library in honor of her husband.

The foundations for a chemical laboratory at Oberlin College have recently been laid. The chemical laboratory at Hobart College is to be enlarged and one of the dormitories will be fitted up for the work in physics, biology and geology.

Dr. J. N. Langley will be deputy professor of physiology at Cambridge University for Sir Michael Foster, M.P.

Mr. J. H. Jeans of Trinity College, Cambridge, has been elected to the Isaac Newton Studentship in astronomy and physical optics.

Mr. H. Woods, M.A., of St. John's College, has been appointed University lecturer in paleozoology for five years from Michaelmas, 1899.

Dr. Drude, associate professor of physics at Leipzig, has been called to a full professorship at Giessen.

Dr. Königsberger has become docent in physics at Heidelberg; Dr. F. Streintz in electro-chemistry at Göttingen, and Dr. Richard Meyer in chemistry at Berlin.

SCIENCE

FRIDAY, APRIL 6, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE PREVALENT DISEASES IN THE PHILIPPINES.**

WE have the honor to submit to you a brief account of our work and movements in carrying out your commission to study the prevalent diseases in the Philippine Archipelago. Your commissioners, consisting of Dr. Simon Flexner and Dr. L. F. Barker, to whom were voluntarily attached Messrs. J. M. Flint and F. P. Gay, of the Medical School, the latter having given their time and paid all their own expenses, sailed from Vancouver on March 29, 1899, and arrived in Manila, May 4th, where they immediately established themselves for the purpose of the work mentioned. Owing to the military situation it was found impracticable to visit other ports in the Archipelago, or to penetrate into the interior of the Island of Luzon. The entire time, therefore, of the commission was spent in the study of disease existing among the natives and American troops in Manila and at Cavite.

WORK IN JAPAN AND HONG-KONG.

As transport sailings were uncertain and the passage out by them slow, it was decided to save time and go by fast steamer, the Canadian Pacific Railway giving es-

* Report upon an expedition sent by the Johns Hopkins University to President Gilman, Doctors Welch and Osler, Philippine Committee of the Johns Hopkins University Medical School.

pecial rates to the commission on tickets around the world.

The original plan of your commissioners was to proceed directly to Manila by way of Hong-Kong, at which latter port it was intended to stop only long enough to outfit for the tropics and to catch the earliest steamer sailing for Manila. After consideration of the probability that certain new kinds or phases of disease, not occurring in temperate regions, might be encountered in the Archipelago, and of the fact that the diseases of the Philippines would probably have much in common with those of Japan, it was decided to spend one week in Japan, where modern hospitals could be visited and advantage taken of the results of the study of tropical disease by highly trained and eminent Japanese physicians. The decision proved to be valuable in many ways; and we especially desire to express our obligations to Professors Aoyama, Mitsukuri, Miura and Kitasato, who showed us many courtesies. The opportunity to see in the Japanese hospitals pure and mixed examples of beri-beri assisted us greatly in our subsequent studies, as did also the observations on dysentery made in the Institute for Infectious Diseases at Tokio.

While outfitting at Hong-Kong we improved the opportunity to study the bubonic plague, which was still prevailing at that port. This study was made easy by the generosity and courtesy of the English Civil Physician, Dr. James Lowson, in charge of the Plague Hospital and Mortuary. The study begun in this way was extended when two months later we returned to Hong-Kong, en route to America. At this time a considerable exacerbation of the disease had taken place, and within a week or ten days we saw several scores of cases and performed many autopsies. The several forms of infection: inguinal; axillary; tonsillar and cervical and pulmonary, were thus encountered. Bacteriological examinations were made and tissues collected for future study. Two of the party (Dr. Barker and Mr. Flint) spent on the return journey three weeks (at their own expense) in India, where the great epidemics of plague there raging were observed.

ARRIVAL IN MANILA.

Immediately upon our arrival in Manila quarters were sought at the 'Hotel de Oriente.' Very insufficient accommodations were secured for a limited time, as the sudden accession of families of Army and Naval officers had strained the hotel to its fullest capacity. Having been forewarned of the conditions of living in Manila, we took the precaution to bring with us from Hong-Kong a group of Chinese servants, intending to set up house-keeping if practicable. After much difficulty a small house was secured in San Miguel, where, by hiring parts of the furnishings and buying what could not be rented, a temporary establishment was secured.

Within a few hours after our arrival the credentials and private letters brought were presented to Colonel Woodhull, Surgeon-in-Chief to the 8th Army Corps and to General Otis. Colonel Woodhull afforded us every opportunity to prosecute our work in the military hospitals. Although no special introduction was in our possession, we quickly met Dr. Bournes, chief health officer of Manila, who opened to us the hospitals under his charge. Somewhat later we met Dr. Pearson, Chief Naval Surgeon, who opened the Naval Hospital at Cavite to us.

HOSPITALS AT MANILA.

Civil Hospitals.—These consist of a large hospital within the walled city, *San Juan de Dios*. It has a capacity of from 250 to 300 beds and accommodated during our stay both natives and Europeans. The number of European patients was small. When the military hospitals were much crowded a certain number of wounded prisoners of war were accommodated. The hospital contained chiefly native medical cases of both sexes. The *San Lazaro* or leper hospital, in the outskirts of Manila, contained from 80 to 100 lepers during our stay. These had come from Luzon, almost exclusively from Manila and its immediate surroundings. The two sexes are provided for in separate, large and airy wards. One wing of the building, having a private entrance, is devoted to native prostitutes who apply regularly for examination and are incarcerated here and treated medically when found to be suffering from venereal disease.

Military Hospitals.—These consisted, beside the regimental hospitals which were virtually detention camps, of three Reserve Hospitals—the 1st, 2d and 3d Reserve Hospitals; a convalescent hospital on Corregidor Island and the Hospital Ship *Relief*, which was anchored in the bay. The First Reserve Hospital, under the control of Major Crosby, had been originally the Spanish military hospital. It had been from time to time, by the erection of tents over platforms raised a foot or two from the ground, increased in capacity until in July it contained 1200 or more beds. The Second Reserve Hospital, under the control of Major Keefer, was a transformed modern school building and because of its limited capacity (250 beds), high ceilings and wide corridors it made a model hospital. The Third Reserve Hospital had just been established towards the end of our visit and was smaller than the others and intended as a convalescent hospital. The hospital at Corregidor is a temporary structure and intended for convalescents. It is especially well adapted for its purpose because of the high and hilly character of the island and its complete investment by the sea. The *Relief* was used as a hospital for acute cases; but some time before we left the acute cases were transferred to the Reserve Hospitals and the *Relief* sailed for San Francisco with invalided men.

The Reserve Hospitals accommodated especially American sick and wounded; but a ward in the First Reserve Hospital was set aside for the Filipino wounded.

After the outbreak of beri-beri at Cavite a hospital under military control was established at San Roque in the remains of the Spanish Marine Hospital which had been wrecked by the insurgents.

Naval Hospital.—A small hospital for sick seamen and marines was established at Cavite. Through the courtesy of Dr. Pearson this was open to us for clinical studies.

Clinical Pathological and Bacteriological Laboratory.—Through the kindness of Colonel Woodhull and Major Crosby, the officer-in-chief of the First Reserve Hospital, a small Filipino house, situated on the banks of the Pasig, was given us in which to establish a laboratory. This was done on the second floor of the house. The expense of putting up working tables was kindly borne by the Medical Corps of the Army. The laboratory equipment was set up in this building and within a very few days after our arrival work was begun. We desire to speak of the co-operation of the Medical Staff of the hospital who afforded us every opportunity to visit the wards and many of whom joined or assisted us in clinical and pathological work. We wish especially to acknowledge the co-operation and assistance of Lieut. Richard P. Strong, a graduate of the J. H. U. Medical School, who had on our arrival already begun to do laboratory work and who gave up much of his valuable time in furthering our interests. It was found unnecessary to establish laboratories in the other hospitals, in the first place because all were connected with the Frst Reserve by the Signal Service telegraphic system of which we had free use; and next because all the dead were carried to the morgue in conjunction with the First Reserve Hospital. We went or were frequently called to the other hospitals to make clinical and bacteriological examinations.

With few exceptions, all the dead were subject to autopsy. Post-mortem examinations were made at the Civil Hospitals upon natives and at the Military Hospital upon all that died. Exceptions were made only in the cases of those dead from gunshot wounds, when, if pressed for time, necropsies were sometimes omitted.

PREVAILING DISEASES.

The subject of the prevalent diseases may be considered as they affect (1) the natives, and (2) Europeans and Americans, especially the American garrison.

Diseases affecting Natives.—(*a*) *Skin Diseases.* Of the skin diseases prevailing among the natives, aside from smallpox and other specific exanthemata, may be mentioned (1) diseases of the scalp, which are very frequent; (2) dhobie itch; and (3) an affection which resembles closely and which is probably identical with Aleppo boil (Delhi boil, Biskra button, *epidemische Beulenkrankheit*). (*b*) *Smallpox.* This disease has been so generally prevalent in Luzon that the natives have to a large extent lost fear of it. All evidence points to the greatest carelessness in preventing its spread during Spanish times. Isolation of the sick and disinfection of the habitations seem not to have been attempted, and vaccination, even among the Spanish garrison, had not been carried out. Under these circumstances it could be no surprise that after the American occupation the disease should appear and even become epidemic. The epidemic which appeared early last year was promptly met by Br. Bournes, who caused the Spanish garrison still in Manila and the natives and Chinese within the city to be vaccinated. In order to insure satisfactory results he found it necessary to establish a vaccine farm in which young *carabao* were used for the preparation of the virus. Under the influence of this measure and by the aid of isolation of the sick the disease had in May practically disappeared within the military lines about Manila. (*c*) *Leprosy.* A definite focus of this disease exists in Luzon. The cases, in the neighborhood of 100, which were confined in the San Lazaro Hospital came from Manila and the country immediately surrounding that city. The disease affected both sexes, being more frequent in adults, although also present in half-grown boys and girls. The commonest forms were the tubercular and mutilating. Autopsies were performed upon several cases that had died during our stay. (*d*) *Tuberculosis.* Accurate statistics of the extent of the prevalence of this disease are difficult if not impossible to obtain. That the disease is a common one is indicated by several facts. It is frequently met with in the native hospitals, where it may have been recognized during life or is disclosed at autopsy. Many cases of supposed beriberi which we autopsied at San Juan de Dios proved to be tuberculosis. It is possible that the two diseases had co-existed, for we found such combinations freely recognized by Japanese physicians in the hospitals in Japan. Tuberculosis of the lungs was also found as a common complication in leprous individuals that came to autopsy. A not very infrequent spectacle met with on the streets are much emaciated and weak natives, affected with suggestive coughs and free expectoration. While it is not certain that these individuals were examples of tuberculosis, there is strong probability that this explanation of their condition is the correct one. (*e*) *Venereal Disease.* Syphilis, by general agreement (statistics not available), does not prevail unduly. Chancroids and gonorrhœa are, on the other hand, very common. The majority of the prostitutes confined in the San Lazaro were victims of these two diseases. A very common complication of the soft sore, owing to lack of cleanliness, is swelling and suppuration of the inguinal glands. (*f*) *Beri-Beri.* This disease is well known among the natives. It would appear to be epidemic and endemic in Luzon. It is, judging from cases met with in San Juan de Dios Hospital and the statements of native physicians, constantly appearing in a sporadic form. During our stay an epidemic appeared among the Filipino prisoners confined at Cavite. Some 200 cases developed in a few weeks; the mortality ranged from 20 to 30 per cent. The several recognized forms of the disease —œdematous, paralytic, and mixed—were encountered. Clinical and bacteriological studies were made upon the living, and the dead were subjected to autopsy and bacteriological examination. The difficulty of getting to and fro between Manila and Cavite on account of the impossibility of land communication, made this part of our work difficult and time-consuming. A considerable collection of pathological material and other data has been made. This material is now in process of study and arrangement.

Diseases affecting Americans.—The chief causes of disability among the American land forces are the enteric diseases. These are diarrhœa, dysentery, typhoid fever, and gastro-intestinal catarrhs. Many of the diarrhœas are merely preliminary to the symptoms of dysentery. Other infectious fevers are relatively infrequent. A small number of cases of scarlet fever and diphtheria only were encountered. The malarial fevers prevailed but not seriously during the months of May, June and July. (*a*) *Dysentery.* This disease is responsible for the greatest amount of invalidation and the highest mortality. It appears in acute, sub-acute, and chronic forms. The chronic form is sometimes attended by secondary abscess of the liver. The acute form may end in 24, 48, or 72 hours. In it the whole of the large intestine and usually the lower portion of the ileum is involved. The mucous membrane of the gut is swollen, congested and œdematous, in places hemorrhages have taken place into the mucous membrane and the sub-mucosa is swollen and its blood-vessels greatly dilated. No ulcers existed in such cases. Amœbæ were absent or very difficult to find in the fresh stools and in the intestinal contents immediately after death. In the sub-acute and chronic forms ulcers are present in the mucosa; the coats of the intestine are greatly thickened; at times large sloughs of mucous membrane, partly detached, occur, and the lesions are confined to the large intestine. Amœbæ are more commonly present in these cases but are variable as to actual occurrence and numbers. Large hepatic abscesses, usually single, were encountered in a number of these cases. Amœbæ were variable in the contents of the abscesses. In one very large abscess, occupying both right and left lobes of the liver, no amœbæ but a pure culture of the Staphylococcus pyogenes citreus was obtained. The clinical study of the cases of dysentery with reference to amœbæ was equally unsatisfactory. In cases with marked symptoms both in patients confined to bed and those beginning to go about but still with persistent loose bowels, these organisms were frequently missed; while in instances ready to be discharged they might, at certain examination, be found to be very abundant. In morphology, the amœbæ studied corresponded with the amœba coli found in Egypt and in this country. The bacteriological study of cases of dysentery was carried out upon the fresh stools of acute and chronic cases and with the intestinal contents, mesenteric glands, liver, etc., of cases dying and subjected to autopsy. The intestinal flora was studied in its entirety by means of plate cultures.

A variety of micro-organisms were separated. Many of these were well-known species or occurred normally in the situations in which found. Tests with blood sera for agglutination were made and those organisms giving positive reactions were separated for further study. Two groups of bacilli were thus differentiated: (1) Having affinities with the group of bacillus coli communis. The agglutination was variable, being constant and sensitive with the blood-serum of the same individual (host) and inconstant, and active in relatively strong solutions only, in serum from other individuals. (2) Having affinities with the group of bacilli of which bacillus typhosus is the type. Agglutination constant and sensitive with blood-serum of host as well as the sera of other individuals suffering from dysentery. Inactive with normal serum, serum from cases of typhoid fever, malaria and beri-beri. A bacillus belonging to the second group, which is still under study, would seem to agree with the bacillus dysenteriæ isolated by Shiga from cases of endemic dysentery occurring in Japan. It is regarded by us as an important factor in the causation of the dysentery of the Philippine Islands. Experiments in immunization of animals and the production of vaccine are in progress. (*b*) *Typhoid fever*. The total number of cases of typhoid fever in the hospitals during May, June and July was far below those of dysentery; the number of deaths also was less. It was, however, a frequent affection among Americans. The examination of the blood, microscopically and with the Widal test, was of the greatest help in diagnosis. The disease came to autopsy presenting the classical intestinal lesions and also in atypical forms. In the small number of autopsies made upon those dead of this disease, several instances of slight intestinal envolvement or even entire escape were met with. These cases would have remained very obscure or even undetermined except for the Widal reaction and bacteriological examination. In some instances the typhoid bacillus was found widely disseminated throughout the body, the autopsy being made immediately after death. (*c*) *Malarial Fevers*. A large proportion of the cases sent in from the field and outlying military stations where examinations had to be hastily made as instances of 'malaria' or 'intermittent fever' turned out to be cases of other diseases (typhoid, dysentery, etc.). A number of true cases of malarial fever were, however, met with, and in the blood of these the characteristic parasites, identical with those occurring in other places in which studies of the blood have been made, were found. No quartan parasites were met with, but cases of quartan affection doubtless exist. Typical infections with the 'tertian' and 'æstivo autumnal' varieties of the parasite were encountered by us, and by microscopists among the Army physicians in the Reserve Hospitals and on the *Relief*. One of the fatal cases of malaria was complicated with acute lobar pneumonia. The cases of 'calentura perniciosa' which occur in Mindoro, Mindanao and in certain parts of Luzon should be studied as soon as these regions are accessible. The Archipelago is favorable also for the study of the relation of mosquitos and other insects to malarial infection. Some of the malarial cases were undoubtedly *recidives*, imported from Cuba or elsewhere. A very small number of deaths was referable to malaria. Two instances of acute malarial infection came to us for autopsy. On the other hand, several instances of malarial pigmentation of the organs, in persons dying from other diseases, were encountered. Parasites in the latter cases were absent. These men had, as a rule, been in Cuba or Puerto Rico during the Spanish war.

(*d*) *Tuberculosis*. A number of cases of pulmonary tuberculosis developed among the soldiers in the American troops. A definite history of exposure to wet and various hardships was elicitable in many of these cases.

(*e*) *Dengue*. At Cavite there occurred a large outbreak of an epidemic fever of short duration (a few days) known locally as Cavite fever. Almost all who remained in Cavite for any length of time were attacked. Second and third attacks were common. Muscular pains were severe in some cases and not in others. A slight exanthem was present in many of the cases. Flushing of the face, restlessness and general malaise accompanied the fever and rapid heart action. Malarial parasites were not present in the blood, nor did the serum from such cases agglutinate cultures of the typhoid bacillus. The epidemic is regarded as one of Dengue.

(*f*) *Tropical Ulcers*. A number of the American soldiers suffered from a form of indolent ulceration, locally known as 'tropical ulcer.' These ulcers occurred singly sometimes but were more often multiple. They began as small pustules, which gradually extended. They were most frequent among those who had been compelled to make long marches through swampy districts, and the patients themselves attributed the ulceration to 'poisoning' in the marshes.

(*g*) *Wound Infection*. Our experience with wound infections was rather limited. The other problems undertaken, regarded as more important as bearing on the general question of disease and its causation in the Islands, left but little time and opportunity to attack this interesting subject. Certain observations of interest were made. Pyogenic infections due to the common pus cocci occurred. In a small number of gunshot wounds causing compound fractures emphysematous gangrene occurred and the bacillus aerogenes capsulatus was isolated. In one instance of compound fracture of the tibia a spore-bearing bacillus was associated with the bacillus aerogenes capsulatus. It was found in cover-slip preparations from the original wound in the first set of cultures. It could not be further transplanted and hence was not identified. In two other cases was the bacillus aerogenes met with, one a case of peritonitis following infection of the intestine from an incarcerated hernia, and the other also a case of peritonitis but secondary to perforation of a typhoid ulcer of the intestine. The army surgeons were enthusiastic as to the adequacy of the 'First-Aid Package' in limiting the number of wound infections.

CLIMATOLOGICAL AND HYGIENIC CONDITIONS.

The climate is that of continual summer. There is a wet season (S. W. Monsoon) and a dry season (N. E. Monsoon). The hottest period is at the end of the dry and the beginning of the wet season—precisely the period of our visit. The climate from November to March is said to be delightful. In the worst season of the year the climate is very trying and especial precautions are to be taken if Americans are to keep well there. The extremes of temperature are not great, but the constancy of the high temperature, together with a high degree of humidity, make the climate peculiarly enervating. We were interviewed at length while in Manila, officially by the U. S. Philippine Commission, with regard to climate and the hygienic precautions to be observed, as well as with regard to other medical problems in the islands. The climatic conditions and the hygienic precautions to be taken will form the subject of a fuller report to be made later.

The above represents, briefly stated, the results achieved by your expedition sent to the Philippines. As will be patent to you, not a little yet remains to be done before the scientific portion of the work is completed. This portion of the report is for the present only hinted at or withheld until it shall have been finished. It is the intention of your commissioners to make careful studies of the material relating to beri-beri, dysentery, malarial and typhoid fevers, leprosy, and the bubonic plague, which has been collected. These studies, with the exception of that relating to dysentery, will be carried out upon preserved material, and the labor involved, which has been divided between Baltimore and Philadelphia, will necessitate that some time must elapse before the finished report is forthcoming. The task of completing the study of the bacillus isolated from cases of dysentery has been assigned to Dr. Flexner, who was principally engaged with that theme during the residence in Manila. In order to carry out the experiments as designed, an outlay for experimental animals and their maintenance will need to be made. It is known to you that the original sum so generously contributed by friends of the University and appropriated for the use of your commission has been exhausted, and that private means have been drawn upon to defray a part of the expense involved. We would respectfully draw attention to this fact and to the further expenses to be incurred, and request direction as to your wishes regarding these matters.

We wish to express our deep gratitude to Messrs. Flint and Gay, whose untiring efforts during our residence in Manila made it possible to accomplish far more than we could have done unaided. It is a pleasure to acknowledge also many kindnesses on the part of Mr. John W. Garrett.

That we are deeply indebted to the officers in the Medical Service of the U. S. Army and Navy for opportunities and aid is evident from the report preceding. Courtesies and kindnesses extended by various citizens of Manila, European and native, are here also gratefully acknowledged.

SIMON FLEXNER,
LEWELLYS F. BARKER.

*A POPULAR ACCOUNT OF SOME NEW FIELDS OF THOUGHT IN MATHEMATICS.**

AT the beginning of the nineteenth century elementary arithmetic was a Freshman subject in our best colleges. In 1802 the standard of admission to Harvard College was raised so as to include a knowledge of arithmetic to the 'Rule of Three.' A boy could enter the oldest college in America prior to 1803 without a knowledge of a multiplication table.† From that time on the entrance requirements in mathematics were rapidly increased, but it was not until after the founding of Johns Hopkins University that the spirit of mathematical investigation took deep root in this country.

The lectures of Sylvester and Cayley at Johns Hopkins University, the founding of the *American Journal of Mathematics* and the young men who received their training abroad co-operated to spread the spirit of mathematical investigation throughout our land. This led to the formation of the American Mathematical Society eight years ago as well as to the starting of a new research journal, *The Transactions of the American Mathematical Society*, at the beginning of this year. While these were some of the results of mathematical activity, they, in a still stronger sense, tend to augment this activity.

In Europe such men as Descartes, Newton, Leibniz, Lagrange and Euler laid the foundation for the development of mathematics in many directions. These men, as well as a few of the most prominent in the early part of the nineteenth century, were not specialists in mathematics. They were familiar with all the fields of mathematical activity in their day and some of them were well known for their contributions in other fields of knowledge. The last

* Read at the regular winter term meeting of the Alpha Chapter of Sigma Xi, Cornell University.

† Cajori, The teaching and history of mathematics, 1890, p. 60.

three-quarters of a century and especially the last two or three decades have witnessed a marvelous change in the mathematical activity of Europe. Mathematical periodicals have sprung up on all sides. A number of mathematical societies have been organized and many of the leading mathematicians have confined their investigations to comparatively small fields of mathematics.

The rapid increase of the mathematical literature created an imperative need of bibliographical reviews. This need was met in part by the establishment at Berlin, in 1869, of a year-book devoted exclusively to reviews of mathematical articles, *Jahrbuch über die Fortschritte der Mathematik.* The 28th volume of this work reached our library a short time ago. It contains over 900 pages. With a view towards further increasing the facilities to keep in touch with this growing literature, the Amsterdam Mathematical Society commenced the publication of a semi-annual review, *Revue Semestrielle*, in 1893. In the last number, 236 periodicals are quoted, each of which contains, at times, mathematical articles that are of sufficient merit to be noted. Each of the four countries, France, Germany, Italy, and America publishes over thirty such periodicals.

One of the characteristic features of our times is the prominence of the spirit of co-operation. The mathematical periodicals and the mathematical societies are evidences of this spirit. In quite recent years international mathematical congresses have given further expression of the wide-spread desire to co-operate with even the most remote workers in the same fields. The first of these congresses was held in Zurich in 1897, and the second is to be held during the coming summer in connection with the Paris Exposition. The same spirit led in 1894 to the starting of a periodical, *L'intermediare des mathématiciens*, which is devoted exclusively to the publishing of queries and answers in regard to different mathematical subjects.

This desire for extensive co-operation is tending towards unifying mathematics and towards laying especial stress on those subjects which have the widest application in the different mathematical disciplines. This explains why the theory of functions of a complex variable and the theory of groups are occupying such prominent places in recent mathematical thought.*

Before entering upon a description of some of the fields included in these subjects and the interesting problems which they present, it may be well to state explicitly that our remarks on mathematics will have very little reference to its application to other sciences. To the pure mathematician a result that has extensive application in mathematics is just as important and useful as one which applies to the other sciences. Mathematics is a science which deserves to be developed for its own sake. The thought that some of its results may find application in other sciences is, however, a continual inspiration, and those who investigate such applications sometimes add materially to the development of mathematics.

The curve representing a function of a single variable was the principal object of investigation during the eighteenth and a great part of the nineteenth century.† The investigations of Abel and Cauchy on power series during the early part of the nineteenth century furnished the foundation for the modern theory of analytic functions—a theory which has been adorned by the labors of some of the most brilliant mathematicians of the preceding generation and which is claiming the attention of some of the foremost thinkers of the present time. Quite recently this theory has been made

* Cf. Klein, *Chicago Mathematical Papers*, 1893, p. 134.

† Lie, *Leipziger Berichte*, vol. 47, p. 261.

more accessible to English readers by the treatises of Forsyth and of Harkness and Morley.

The critical spirit of our age is, in a large measure, due to the study of the theory of analytic functions. "Newton assumes without hesitation the existence, in every case, of a velocity in a moving point, without troubling himself with the inquiry whether there might not be continuous functions having no derivative."* When it was discovered that such functions exist and that the works of some of the greatest mathematicans of the preceding centuries have to be modified in some instances, mathematicians naturally became much more exacting in regard to rigor, and thus ushered in an age which may be compared with the times of Euclid with respect to its demands for rigor. Whether our critical age will produce a work which, like Euclid, will serve as a model for millenniums cannot be foretold, but it seems certain that works which can stand the critical tests of this age will stand the tests of all ages.

The critical spirit of our times is the foundation of what has been styled the *arithmetization of mathematics*. This movement which the late Weierstrass knew so well to lead is pervading more and more the whole mathematical world. We are rapidly banishing from our treatises the term quantity and replacing it by the word number. Our geometric intuitions are forced into the background and logical deductions from definitions are taking their places. Who can conceive of curves which have no tangent at any of their rational points in a given interval? Nevertheless it is well known that such curves exist. An account of such functions was first published by Hankel in 1870.†

Mathematicians find themselves in a great dilemma at this point. Geometric intuition has been such a strong instrument of research and has given so much life and beauty to mathematical investigation that mathematicians cling to it, as their own lives. It is an enormous price when rigor can be purchased only with geometric intuition. Yet, in the present stage of mathematical thought, this seems to be the only thing that will be accepted, and mathematicians stand helpless before this decree.

A few examples may throw some light on this subject. What do we understand by the length of a continuous curve? The intuitionalist says, if we connect different points of the continuous curve by straight lines and find the sum of the lengths of these straight lines, then the length of the curve will be the limit of this sum as the number of the points is indefinitely increased. Jordan was the first to call attention to the fact that this sum need not have a limit. Hence there are continuous curves which do not have any length according to the ordinary definition of length. In fact a number of area-filling curves have recently been studied, and Cantor has shown that a multiplicity of any number of dimensions can be put in a one to one correspondence with a multiplicity of one dimension.

These are some of the facts which have compelled mathematicians to construct their own worlds—the number worlds. Conclusions drawn in one number world do not necessarily apply to another. When a problem is under consideration the number world is so chosen as to meet the demands of the problem. For instance, the constructions and demonstrations of Euclid's geometry seem to require only a space composed of quadratic numbers.* Hence it appears that we do not need to assume that space is continuous in order to demonstrate the theorems of elementary geometry. Simi-

*Klein, *Evanston Colloquium*, 1894, p. 41.

†Cf. Pierpont, *Bulletin of the American Mathematical Society*, vol. 5, p. 398.

*Cf. Strong, *Bulletin of the American Mathematical Society*, vol. 4, 1898, p. 443.

larly in algebra, we are laying more and more stress upon a distinct statement of the number world (the domain of rationality) in which we are operating. Such specifications add a clearness and rigor to our work which would otherwise scarcely be possible.

This refinement which the mathematical thought of to-day is so actively cultivating is not restricted to the finite region. Mathematical infinity is receiving its share of attention. It is well known that it is sometimes desirable to regard the infinite region as a single point. This is, for instance, the case in the transformation known as inversion. Again, in ordinary projective geometry it is generally convenient to regard the infinite region as of one lower dimension than the finite, so that the infinite region of a plane is merely a line and the infinite region of space is a plane. The student of differential calculus is, moreover, familiar with the infinite variable and the many simplifications which its uses make possible.

The most fruitful investigations along this line are those on multiplicities (Mengenlehre, ensembles). Any total of definite and clearly defined elements is said to form a multiplicity. If two multiplicities are simply isomorphic, *i. e.*, if there is a 1, 1 correspondence between the elements of the multiplicities, they are said to be equivalent, or to have the same power. For example, it is easy to prove that all the positive rational numbers are equivalent to the natural numbers. To do this we may associate all the rational numbers p/q for which the sum $p+q=n$ any positive integer. We thus have the $n-1$ numbers.

$$\frac{n-1}{1},\ \frac{n-2}{2},\ \frac{n-3}{3},\ \cdots,\ \frac{2}{n-2},\ \frac{1}{n-1}.$$

We may let 1 correspond to 1; the numbers for which $n=3$ correspond to 2 and 3; the numbers for which $n=4$ correspond to 4, 5 and 6, etc. We thus obtain the following 1, 1 correspondence between all the rational numbers and the positive integers:

$$\tfrac{1}{1};\ \tfrac{2}{1},\ \tfrac{1}{2};\ \tfrac{3}{1},\ \tfrac{2}{2},\ \tfrac{1}{3};\ \tfrac{4}{1},\ \tfrac{3}{2},\ \tfrac{2}{3},\ \tfrac{1}{4};\ \tfrac{5}{1},\ \tfrac{4}{2},\ \tfrac{3}{3},\ \tfrac{2}{4},\ \tfrac{1}{5};\ \cdots$$
$$1,\ 2,\ 3,\ 4,\ 5,\ 6,\ 7,\ 8,\ 9,\ 10,\ 11,\ 12,\ 13,\ 14,\ 15,\ \cdots$$

It may be observed that we do not need to reduce the rational fractions to their lowest terms to effect this correspondence. This method of proof is due to Cantor, who has also proved that all algebraic numbers are equivalent to the natural numbers.* How important and far-reaching the investigations along this line are may be inferred from the fact that Jordan has employed them to serve as a foundation of the elementary part of the second edition of his magistral 'Cours d'analyse.'

A large number of mathematical problems may be reduced to equations involving a single unknown. The solution of such equations has occupied a prominent place in the mathematical literature for centuries. The problem is so difficult that it has been attacked from a number of different points and by means of a large variety of instruments. The instrument which has proved to be the most powerful and far-reaching is substitution groups. By means of it Abel succeeded in 1826 to prove that an equation whose degree exceeds four cannot generally be solved by the successive extraction of roots † and Galois a few years later sketched a far-reaching theory of equations which rests upon the theory of these groups.

In recent years it has been recognized (especially through the labors of Sophus Lie) that the theory of groups has very extensive and fundamental application in a large number of the other domains of mathematics. About a year ago the great French mathematician H. Poincaré showed in an article, published in the Chicago *Monist* ‡ how this concept may be employed in laying the foundations of elementary

* Cantor, *Crelle*, vol. 77, 258; cf. vol. 84, p. 250.

† *Crelle*, vol. 1.

‡ October, 1898.

geometry. It should be observed that the theory of groups is intrinsically based upon the fundamental concepts of mathematics. It is not a superstructure. It stands on its own foundation and supports more or less a number of other mathematical structures.

As this theory is less known than most of the other extensive branches of mathematics it may be desirable to enter into some details. It is evident that there are rational functions of n independent variables $(x_1, x_2, x_3, \cdots, x_n)$ which are not changed when these variables are permuted in every possible manner. Such functions are said to be symmetric in regard to these variables. The sum of any given power of these variables $(x_1^a+x_2^a+x_3^a+\cdots+x_n^a)$ is an instance of a symmetric function. These functions occupy one extreme. The other extreme is furnished by functions such as $x_1+2x_2+3x_3+\cdots nx_n$ which change their value for every possible interchange of the variables. Most of the functions are of neither of these extreme types.

Suppose that a function $\varphi\ (x_1, x_2, \cdots, x_n)$ is not changed by either of two interchanges of its independent variables. Such interchanges are called substitutions and they may be represented by S_1 and S_2. Since φ is not changed by either of the substitutions S_1, S_2, it cannot be changed by the substitutions which are equivalent to the succession of these substitutions taken in any order. All such substitution may be represented by $S_1^{\alpha}\, S_2^{\beta}\, S_1^{\gamma}\, S_2^{\delta} \cdots$.* Since only a finite number of permutations are possible with n letters it follows that $S_1^{\alpha}\, S_2^{\beta}\, S_1^{\gamma}\, S_2^{\delta} \cdots$ can represent only a finite number of distinct substitutions. The totality of these substitutions is said to be a *substitution group.* Hence we observe that every rational function belongs to some substitution group.

It was soon observed that an infinite number of functions belong to the same substitution group and that all of these functions can be expressed rationally in terms of one of them. The researches of Abel, Galois, and Jordan, were based upon these facts and they show that the most important problems in the theory of equations involve the theory of substitution groups. The theory of groups was thus founded with a view to its application to a subject of paramount importance. A broad mathematical subject can, however, not grow vigorously and harmoniously as long as it is studied with a view to its direct applications to other mathematical subjects. It must be free to expand in all directions. That freedom for which the human race has ever been struggling must be vouchsafed to such fundamental subjects before they will exhibit their great fertility and far reaching connections. Less than three years ago the first work on the theory of groups that does not consider its application * was given to the public, but the mathematical journals have been publishing a large number of memoirs along the same line for a number of years.

In defining a substitution group we implied only two conditions; viz, no two substitutions of the group are identical and if we combine the substitutions in any way we obtain only substitutions which are already in the group. Substitutions obey *per se* some other conditions; *i. e.*, when they are combined (multiplied together) they obey the associative law and if we multiply a substitution by (or into) two different substitutions the products will be different. In general we say that any finite number of operations which obey these four conditions constitute a group; *e. g.*, all the rotations around the center of a regular solid which make the solid coincide with itself constitute a group, the n n^{th} roots of unity constitute a group with respect to multiplication but not with respect to addition, etc.

* The exponent indicates the number of times the substitution is employed in succession.

*Burnside, 'Theory of groups of a finite order,' 1897.

While the bulk of the mathematicians are reveling in the new fields of thought which are opening up on all sides, without any thought in reference to any immediate practical application of their results, there is fortunately a goodly number whose main efforts are devoted towards making some of these new results useful to the investigators in some of the other sciences. As an instance of fairly recent work of the latter kind, we may mention the study of linkages with a view towards describing a straight line. Although the straight line is of such fundamental importance both in pure and applied mathematics, yet it seems it was not until the latter half of the nineteenth century that a mechanical device was discovered by means of which such a line can be described.

In 1864 M. Peancellier, an officer of engineers in the French army, discovered the well known device to describe a straight line by means of an instrument composed of seven links. "His discovery was not at first estimated at its true value, fell almost into oblivion, and was rediscovered by a Russian named Lipkin, who got a substantial reward from the Russian government for his supposed originality. However M. Peancellier's merit was finally recognized and he has been awarded the great mechanical prize of the Institute of France, the Prix Montyon."*

Although the straight line and the circle occupy such a prominent place in elementary geometry and have been before the eyes of the mathematicians for thousands of years, yet less than half a century has passed since the invention of a mechanical device by means of which the straight line can be drawn. Such discoveries go far towards emphasizing the need of investigations even in the most elementary subjects. Such investigations should, however, be preceded by a thorough knowledge of what has been done along the same lines.

If elementary mathematics is to continue to furnish the best possible preparation for the study of advanced mathematics, it is evident that it has to adapt itself to the rapid changes which are going on in the different branches of mathematics. A need is thus created for elementary text-books which meet the new requirements, and we are happy to be able to state that such books are being produced in our midst. How radical such changes may become cannot be foretold. In his address before the New York Mathematical Society, Simon Newcomb said, "The mathematics of the twenty-first century may be very different from our own; perhaps the schoolboy will begin algebra with the theory of substitution groups, as he might now but for inherited habits."* It is to be hoped that our inherited habits will not furnish an insurmountable barrier to progress in this direction.

In modern times the continent of Europe has always been the most progressive and most of the new theories were first developed in these countries. The theory of invariants seems to be an exception to this rule. The two great English mathematicians, Cayley and Sylvester, developed this theory with great vigor; when their important results became generally known on the continent (largely through the work of Clebsch), they aroused a great deal of interest and they furnished the starting point for many important investigations.

One of the fundamental processes of mathematics is transformation—the deducing of truths from given facts and relations. The expressions which remain invariant when given transformations are performed are naturally objects of great interest and of fundamental importance. Imbued with

*A. B. Kempe, 'How to draw a straight line,' p. 12.

* *Bulletin of the New York Mathematical Society*, 1894, p. 95.

this thought Lie once said, "What do the natural phenomena present to us if it is not a succession of infinitesimal transformations of which the laws of the universe are the invariants?"

It need scarcely be added that all mathematical thought even on the same subject is not running in the same channel. Klein has divided mathematicians into three main categories,* viz, the logicians, the formalists and the intuitionists. The term logician is "intended to indicate that the main strength of the men belonging to this class lies in their logical and critical powers, in their ability to give strict definitions and to derive rigid deductions therefrom. The great and wholesome influence exerted in Germany by Weierstrass in this direction is well known. The formalists among the mathematicians excel mainly in the skillful formal treatment of a given question, in divising for it an algorithm. Gordon, or let us say Cayley and Sylvester, must be ranged in this group. To the intuitionists, finally, belong those who lay particular stress on geometrical intuition, not in pure geometry only, but in all branches of mathematics. What Benjamin Peirce has called 'geometrizing a mathematical question' seems to express the same idea. Lord Kelvin and von Standt may be mentioned as types of this category."

In his address before the Zurich International Congress Poincaré says,† "Mathematics has a triple end. It should furnish an instrument for the study of nature. Furthermore, it has a philosophic end, and, I venture to say an esthetic end. It ought to incite the philosopher to search into the notions of number, space and time; and above all, adepts find in mathematics delights analogous to those that painting and music give. They admire the delicate harmony of numbers and of forms; they are amazed when a new discovery discloses for them an unlooked for perspective; and the joy they experience has it not the esthetic character although the senses take no part in it? Only the privileged few are called to enjoy it fully, it is true, but is it not the same with all the noblest arts? Hence I do not hesitate to say that mathematics deserves to be cultivated for its own sake and that the theories not admitting of application to physics deserve to be studied as well as the others. Moreover, a science produced with a view single to its applications is impossible; truths are fruitful only if they are concatenated; if we cleave to those only of which we expect immediate results the connecting links will be lacking, and there will be no longer a chain."

In closing we may remark that no effort has been made to mention all the new fields of mathematical thought. Mathematics, like the other sciences, seems to offer inexhaustible fields of investigation. As it expands its perimeter increases and hence there is a continually increasing demand for investigators. The fields that have been examined present many difficulties which cannot at present be surmounted. Some of the old difficulties are being removed by the light of the new decoveries. Still we know only a few things even about the fields which have been investigated. It is the exception that something can be done by known methods, the rule is that it cannot yet be done.

When we study the literature of some of the older subjects we are sometimes surprised by the large number of known facts, but when we come to study the subjects themselves and ask independent questions we are generally surprised to learn that so few properties are known. Hence it seems very desirable that the advanced student, at least, should study subjects rather than the known facts in regard to these subjects. In this way a more accurate idea of the

* The *Evanston Colloquium*, p. 2.

† *Revue Générale des Sciences*, vol. 8, p. 857.

true state of knowledge can be obtained. Besides the knowledge of having discovered facts and relations which will enter into the structure of a growing science is the greatest source of pleasure that the student can obtain.

G. A. Miller.

Cornell University,

THE MECHANICS OF SLOW MOTIONS.

The slow continuous motion of a plastic solid (such as clay, wet sand, wax, tallow, lead, etc.), is a phenomenon of considerable interest to elasticians not only because of the natural interest attaching to this remarkable class of solids, but primarily because it is only during the very slow motions of these solids that it is possible to sharply distinguish them from the class of ultra-viscous liquids. It is possible to conceive of a 'perfectly plastic solid,' which, as an ideal body, is altogether free from viscosity, just as we may conceive of a theoretical elastic solid or of an ideal perfect fluid. It is not so easy, however, to secure experimental data upon which one may base his theoretical investigation of the motions of plastic solids and by which his conclusions may be tested.

It occurred to me a few years ago that the kinetoscope offered a ready means of securing almost any desired magnification of the rate of these slow motions and thus presented to us a method of securing the lines of flow and rates of motion for any desired case. The method that I selected for that purpose was as follows: Let the moving body be photographed upon kinetoscope film at stated intervals—every few minutes, or every few hours, as the case may require. After a sufficient number of these photographs have been obtained, the film may be run through an ordinary projecting kinetoscope at the usual rate. In this way the motion that has required several weeks for its production may be reproduced upon the screen within the limits of a few minutes or seconds. I have magnified in this way the rate of motion about 500,000 fold, but of course there is no major limit to the possible rate of magnification. I made the first application of this method of magnifying slow motions to the motion of growing seedlings. Several peas and beans were placed in a glass root cage containing wet sand. The photographs were taken by artificial light at fixed intervals day and night for about three weeks. When the film is run through the kinetoscope the entire growth for the period of three weeks is reproduced in a few seconds. I found the motions of two peas, which were placed upon the top of the soil, especially interesting. These peas found it almost impossible to get their roots into the soil. In one case the root came out of the top of the pea and made directly for the moist soil. It found this too hard to penetrate, but the root continued to grow, the result being that the pea was rolled about the root cage in a very grotesque manner, the root curving and writhing much like an angle worm struggling to get into the soil.

The kinetoscope also shows very clearly the different speeds at which the various parts of the plant grow, and the different speeds at which the same part grows at different times. The greatest variety in the rate of growth exists, as I suppose is well known, and of course the kinetoscope brings out the relative rates of growth in a very truthful and graphic manner. I regret that my first film does not show any considerable part of the growth of the stems of the plant, as after growing a few centimeters the stems opened the lid of the root cage and passed out of range of the camera.

The rather startling results of this method as applied to growing plants has caused me to give some further attention to the matter. At the present time I am preparing some additional films taken from growing seeds. Of course there is no reason why the photographing should not be continued until the plants have bloomed and fruited, if any fact important to mechanics or botany is likely to result from the trouble. Perhaps botanists know of matters in plant growth and plant development that it may pay them to investigate by the same method. I anticipate that some interesting facts concerning the mechanics of the root's motion into and through the soil will result from such studies.

I have taken up the work now being done upon living organisms as merely preliminary to the general problem that I have set before me. It must be several months before enough material can be accumulated for a proper discussion of observed and theoretical results in the motions of plastic solids. The actual results may prove disappointing, but this fact cannot be determined in advance.

CHAS. S. SLICHTER.

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*MARYLAND'S HIGHWAY REPORT.**

THERE is a growing realization in this country that the problems which have to be met and solved in the construction of better highways are, in large measure, geological problems. The most satisfactory outcome of this tendency which has yet appeared in this country is the report on highway improvement in Maryland, which has been recently issued by the Maryland Geological Survey; and the Survey, through these investigations and this report, has rendered the cause of good roads in the country at large an important service.

The work resulting in this report was authorized by the General Assembly of Maryland, in an Act passed early in April, 1898, which provided an appropriation of $10,000 per annum for the investigation of questions of road construction in that State, and for the preparation of reports thereon. Under this act a highway division was at once established under the supervision of the State Geologist, Professor W. B. Clark, and Dr. H. F. Reid was appointed chief of this division; Mr. A. N. Johnson, Mr. St. George Lioussat and Mr. F. H. Schloer, special assistants. It was also arranged that other assistants connected with the different branches of the Survey should cooperate in examining the character and distribution in the State of the road-building materials.

Of the volume before us, which contains the results of these investigations, and which it is hoped may serve as a model for similar work in many other States, it is difficult to give any thing like an adequate synopsis in the brief space allotted for an ordinary book review. In a short introductory chapter, Professor Clark has given a copy of the law under which the work was provided for; and a brief statement as to the purpose and character of the enquiries and investigations carried on during 1898 and 1899. This is followed by a more elaborate chapter by Professor Clark on 'the Relations of Maryland Topography, Climate and Geology to Highway Construction'; a subject which must be thoroughly understood by the highway engineer before he can intelligently plan, locate or construct in any section of country, either a system of highways or an individual road. This chapter includes a brief description of the topographical features of the State and its different geographical subdivisions (coastal plain, Piedmont plateau and the Appalachian region), and the influence these have had and should have hereafter on the location of the roads. The question of temperature is not so important a feature in Maryland as in some of the more northern States, for the reason

*Maryland Geological Survey, Vol. III., 1899, pp. 461. Highway Improvement. Baltimore, Md., W. B. Clark, State Geologist.

that the periods of excessively cold weather here occur less frequently and are much shorter in duration than farther north. The normal annual maximum and minimum temperatures are given for the State as 63°F. and 45°F. respectively. As to the question of rainfall and winds, the conditions in Maryland may be considered as a general average of those in the eastern United States; but the rainfall is by no means uniform in different portions of the State, ranging from 31 inches (at one point on the coast) to 53.5 inches at Sunnyside (Garrett county) at an elevation of 2500 feet above sea level.

The relation of Maryland geology to highway construction is discussed in still greater detail in this same chapter, first as relates to the road bed or foundation, and then as to the character and distribution in the State of road materials. The coastal plain region (which comprises nearly 5000 square miles, or a little more than one-half of the land area of the State) contains mainly unconsolidated deposits of sand, clay and loam. In limited areas however, especially in the western and southern portions of this region, there are found ferruginous gravels (of Potomac, Lafayette or Columbia age) which when properly used are found to have good cementing qualities and make fairly satisfactory road surfaces where there is only moderate travel. The marls of this region have not and probably will not be used to any large extent for highway construction, for the reason that the beds are seldom indurated and the shell are quickly ground to pieces under the wheels. Even the calcareous members of the eocene, which are indurated and exposed along many of the valleys, when crushed and placed upon the road surfaces, usually grind rapidly under the wheels and do not recement with sufficient strength to bear heavy and continuous travel. Probably, however, in Maryland as in portions of North Carolina and elsewhere, the more silicious of these beds will be found to possess sufficient hardness as well as cementing qualities to make excellent roads for light travel.

Some 250 miles of oyster-shell roads have been constructed in the region bordering the head of Chesapeake Bay, at a cost of from $1000 to $2000 per mile, and the large oyster interests in the bay will doubtless continue to furnish considerable supplies of this material in the future. Possibly this surface would wear better if with the crushed shell were added a moderate admixture of sand or a thin covering of finely crushed stone. In many portions of eastern Maryland, as indeed over a large portion of the entire coastal plain region of the United States, for the improvement of the ordinary roads in the deep sandy regions, we shall have to depend upon the proper admixture of clay, and the use of wide tires on draught vehicles to prevent the cutting to pieces of these sand-clay roads during wet weather.

In central and western Maryland the question of satisfactory materials for road building is much more easily solved, as suitable materials are much more abundant and widely distributed. The character and distribution of these materials are discussed in detail and their distribution is shown on an excellent map of the State on a scale of 20 miles to the inch. In the Piedmont plateau region are found trap rocks, including gabbro and diabase, widely distributed which are valuable for road purposes on account of their excellent wearing and fair cementing qualites. The granitic and quartzitic rocks, of which some possess fair wearing quality, are the most abundant material in this region. The compact limestones, which are also widely distributed in this region, have in the past (especially the more siliceous beds) constituted a large portion of the road material used. The igneous rocks (which are generally classed as acid and basic volcanics) are limited to the extreme eastern portion of this appalachian region, and have not yet been employed to any considerable extent for highway purposes.

In part VI. of this report, Dr. H. F. Reid describes the qualities of good road metals and the methods of testing them. He classifies the forces tending to destroy roads into two groups:

First, the wear and tear of travel: (1) by blows of the horses' feet; (2) By the blows of the wheels; (3) By the action of the horses' feet in pulling or holding back, tending to pull the stones out of place; (4) By friction of the wheels, especially when trucks are used; (5) By the pressure on the road surface due to the weight of the vehicle and horses.

Second, the forces of nature, under which he includes: (1) Heavy rains which tend to wash the road; (2) The winds which tend to sweep away all the fine material formed on the road surface by travel instead of allowing it to become consolidated again with the mass of the road; (3) The solution and general chemical decomposition of the surface material through the action of water; (4) The changes of temperature; (5) The heaving action of frost and subsequent breaking up of the surface at times of thawing.

Under the 'Methods of testing Road Material,' Mr. Reid describes briefly: (1) the microscopic examination as showing the structure of the rock; (2) abrasion test, which has been so long practiced in France and other countries; (3) the crushing test, which shows the resistance of the rock to crushing action or blows; (4) the cementation test. Of these abrasion and cementation tests are undoubtedly the most important. For many years the French highway engineers depended entirely upon the abrasion test, but one of the important results arrived at through the investigations of the highway laboratory of the Lawrence Scientific School, under Professor Shaler's direction, is the demonstration of the fact that the cementing power of the road metal, as the surface is ground under the wheels and hoofs, is as important, and in some cases more important than the power of resisting wear; for however hard and tough the road material may be, under the action of the wheels it will be gradually ground into powder, and if it does not possess this cementing power in a high degree, it will be continuously removed from the road surface. With this cementing power developed in a high degree, however, it has been found that fairly soft stone may be used for road surfacing in many cases with decided success.

Part IV., on the present condition of highways in Maryland, by Mr. A. N. Johnson, is of much interest to the student of this great problem of highway improvement in America. Some 2500 miles of these roads were travelled over by Mr. Johnson in carrying on his investigation. The total number of miles of public roads given in Maryland (with a total land area of 9860 square miles) is 14,483; or 1.47 miles of road for each square mile of area. Of this there are 890 miles of stone road, 225 miles of gravel road, 250 miles of shell road, and 13,118 miles of typical American earth road. Of the 890 square miles of stone road about 630 miles were built by turnpike companies and 260 miles have been built by the counties. Unfortunately most of these improved roads were constructed without competent engineering supervision and without proper care as to the grades; and the folly of such practice can not be stated too emphatically nor too often. Perhaps the first urgent need of the typical American highway to-day is that it be properly relocated by a competent engineer before there is any expensive improvement of the surface.

Mr. Johnson also brings out the fact that the average length of the haul for farm products in Maryland, including the distance from farms to the markets and railway stations, is for the State 6.7 miles, ranging in different counties from four to twelve miles. And he estimates the average cost of hauling one ton one mile in Maryland at twenty-six cents, as compared with an average of twenty-five cents for the United States, from seven to twelve cents in England, France and Germany, and from seven to sixteen cents per ton per mile in New Jersey. In a succeeding chapter which must prove of great value to the people of Maryland, Mr. Johnson discusses the methods of constructing and repairing public roads.

The question of road administration in Maryland and in other States and countries is discussed by Dr. Reid, and a large amount of information concerning this subject, in practically every State of the Union, has been brought together in so careful a manner as to make it of permanent value to the country at large. One is amazed to see that in so few of the States have any practical methods been adopted looking to the permanent betterment of the highways. In this great work New Jersey and Massachusetts have taken the lead in building important highways under State supervision and in part at the State's expense. New York is slowly following in their footsteps. But as we run over the list of other States one is struck with either the practical indifference manifested in the majority of them, except in isolated localities, or else the aimless sort of way in which spasmodic efforts are being made toward the improvement of the public highways over which our rural population must travel and must market its products at a cost approximating $600,000,000 per annum greater than this cost would be if all these important highways were in good condition.

Many facts demonstrating the 'Advantages of Good Roads' are brought out by Dr. Reid in a succeeding chapter. In Part III. on the highway legislation in Maryland and its influence on the economic development of the State, Mr. St. George L. Sioussat has not only brought together a large amount of information relative to highway legislation and the early history of Maryland, but he has presented an ordinarily dry subject in such a way as to make much of it interesting, even to the general reader; especially would this apply to the last few pages of his chapter which treats of the building of the national road, which was constructed by the Federal Government from Cumberland, Maryland, to the Ohio River.

At the end of the volume is an appendix of 76 pages in which are brought together the laws of Maryland relating to highways.

The typography and illustrations of this volume, like those of the preceding volumes of the Maryland Geological Survey, are excellent in both selection and execution. There are 35 half-tone plates and maps illustrative of the various topics treated in the report. The maps, which are exceptionally clear and free from crowding, show the distribution of rainfall, temperature, road materials and the main roads of the State; and in addition to the general maps there are separate county maps which show both the principal roads and the materials which can be used best in improving them.

In concluding this review, already too long, I must call attention to another phase of this good-roads problem, and one which should be taken to heart in all portions of the country. The good people of Maryland, like their fellow citizens in other states, have gone through a century or more without a highway system. During the past ten years they have expended on their highways over $6,000,000, most of it wasted in continually patching more than 13,000 miles of ordinary dirt roads, most of which are poorly located; all of them bad at certain seasons; many of them bad at all seasons. Furthermore, as shown by a careful estimate in this report, the traveling and hauling done over these earth roads by the people of Maryland costs them annually not less than $3,000,000 more than it would cost were the more important of these roads transformed into well built modern highways.

That there exists to-day in so important and intelligent a commonwealth, a condition of affairs so costly, and so unnecessarily bad, a condition which greatly retards the material, social and intellectual development of its rural population especially, is deplorable enough; but a still more unfortunate fact is that, looking over the whole of this great country of ours, there are scarce half a dozen states that claim a better record.

J. A. Holmes.

WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS FOR THE YEAR ENDING JUNE 30, 1899.

The report on the work and expenditures of the agricultural experiment stations in the United States for 1899, prepared by Dr. A. C. True, Director of the Office of Experiment Stations, Department of Agriculture, has recently been transmitted to Congress. The general conclusions regarding the present status of the stations are stated in the report in substance as follows:

The work of the stations during the past year has for the most part been along the same lines as heretofore, and in the aggregate a large amount of useful work has been accomplished. By their own efforts and with the aid of the colleges of agriculture and the State boards or commissioners of agriculture, the stations are bringing their work home more closely to the farmers through publications, farmers' institutes, agricultural associations, home reading courses and the press. It is becoming evident that farm practice in this country is being materially affected by the work of the stations, and they are more and more relied upon by our progressive farmers for advice and assistance.

THE FINANCIAL BUSINESS OF THE STATIONS.

The financial business of the stations is now generally conducted systematically and carefully, and with due regard to the limitations of the Hatch Act and the State laws governing their operations. The wisdom of Congress in making the Hatch fund a research fund is every year becoming more apparent. This Department is therefore disposed to more strongly insist on a strict interpretation of this act in this direction, and to hold that it is not only in accordance with the obligation, but also to the interest of the States, to devote the Hatch fund to investigations in agriculture and to supplement this fund as far as may be necessary to promote the interests of agriculture in other lines.

RELATIONS OF COLLEGES AND STATIONS.

The movement for the improvement of courses of agriculture in the colleges with which the stations are connected is steadily growing. The past year has witnessed many changes for the better as regards specialization of the work of instruction and the development of courses suited to the varied needs of students. More then ever before the colleges are reaching out beyond their class rooms and are carrying useful instruction to the farmers through farmers' institutes, correspondence courses, and other forms of so-called university extension. As this outside work becomes better organized, it is more apparent that it belongs to the college rather than the station. At the same time when properly managed it affords efficient means for bringing the results of station work home to the farmer, and thus usefully supplements the publications of the stations. With the return of financial prosperity the States are more liberally endowing the colleges and providing them with better buildings and equipment. As the stations usually make considerable use of the improved facilities given to the colleges, the means for making their work more efficient have been materially improved during the past year.

As the work of both college and station grows in extent and complexity, it becomes more apparent that in order to perform the most efficient service the station should be organized strictly as a separate department of the institution with which it is connected, and that it should have an organization so compact that its work may proceed in accordance with a schedule carefully planned and energetically administered. To secure this end experience shows that it is quite desirable that the station should have a competent executive officer, who can devote his time very largely to planning and directing its operations, managing its general business, and representing its interests before the public. It is encouraging to observe that in several States during the past year these considerations have led to the more complete separation of the business of the station from the general business of the college, and to the appointment of a director of the station as a separate officer.

THE WORK OF STATION OFFICERS AT FARMERS' INSTITUTES.

One of the most striking evidences of the great awakening of our farmers to the importance of technical education relating to their art is the rapid extension of farmers' institutes in all parts of the country during the past few years. Institutes are now held with more or less regularity in 43 States and Territories. It is estimated that during the past year no less than 2000 institutes were held in the United States, which were attended by 500,000 farmers. As this movement progresses there is an increasing demand for the services of experts at these institutes. The farmers best like to hear those men who have made a thorough study of the subjects of which they treat, and who can impart up-to-date information.

In States where the farmers' institutes have been held for a number of years the farmers who attend them are becoming quite familiar with the general principles of agricultural science and the results of the work of the stations as set forth in their publications. It therefore becomes necessary for the speakers at these institutes to devote more time to the preparation of their lectures in order to successfully meet the needs of progressive farmers and give them new information. This fact, as well as the increasing number of institutes, makes it impracticable for station officers to engage very largely in institute work without detracting from their efficiency as investigators. Moreover, to make the thorough investigations which intelligent farmers now insist upon station officers, must devote themselves very closely to this work. It is, therefore, quite clear that we need in this country to devote a corps of institute workers, who can glean from the work of the stations and other sources the fresh information which our farmers demand and can take the time to attend a considerable number of institutes each year. These men must be well trained in the science and practice of agriculture and at the same time must have peculiar gifts as lecturers before popular assemblies. This would not necessarily mean that the station officers should withdraw wholly from the institutes. Without doubt, it is desirable that they should from time to time meet the farmers in this way, but this work should be kept within such limits that it will be merely incidental to their legitimate business as investigators.

THE STATION PUBLICATIONS.

There is still great variety in the character of the publications issued by the stations and much difference of opinion as to what these publications should contain. A large amount of compiled information is still issued. Without doubt, much of this is useful, but it needs still to be remembered that time taken by station officers in preparing such material must be deducted from that which would otherwise be devoted to the work of investigation. Certainly the publications of the stations intended for wide distribution among farmers should be carefully prepared, and the results of investigations should be interpreted in a clear and readable manner. It seems, therefore, unwise to make the station bulletins the vehicle for the publication of the detailed records of experiments or for the scientific presentation of investigations. It would seem better to reserve these details for the annual report. If it is desirable to keep the publication of detailed records of work more nearly up to date this report might be issued in parts, as has been done by a few stations. It would not be necessary to distribute this report to the entire mailing list. If this plan were followed it is believed that the station bulletins might be made more acceptable to the farmers and at the same time the detailed records of work could be put in better shape for the use of students and investigators. Properly managed, this plan would result in greater economy as regards expenditures for printing.

THE INSPECTION SERVICE OF THE STATIONS.

From the very first the stations in this country have been largely engaged in the inspection of commercial fertilizers, and this work has been so efficiently and usefully conducted that from time to time additional inspection duties have been laid upon the stations. The movement for the establishment of different kinds of inspection service under authority of the National and State Governments is growing apace, and and it is very important that the relations of this work to the other functions of the stations should be clearly understood. Soon after the establishment of the stations under the Hatch Act, this Department ruled that the funds appropriated under this Act could not be legitimately applied to pay the expenses of the inspection and control of fertilizers. The same principle holds good with reference to other forms of inspection service demanded of the stations. While the methods and usefulness of inspection in any particular line are still problematical, it may be justifiable for a station to take up this work to a limited extent, but as soon as it becomes a matter of routine business the State should provide funds for its maintenance. If it seems expedient that any part of the inspection service should be performed by the station under State laws and at State expense, the matter should be so arranged as not in any way to interfere with the investigations of the station. It is a great mistake to divert the time and energy of a competent investigator to the toilsome routine work of inspection service.

CO OPERATIVE EXPERIMENTS WITH FARMERS.

The number and importance of the experiments which the stations are conducting in co-operation with practical farmers and horticulturists have greatly increased of late. Thousands of such experiments are now annually conducted in the United States. These range all the way from simple tests of varieties of plants to special experiments in the management of farm or horticultural crops, live stock, or particular operations, such as tobacco curing. It is coming to be more clearly recognized that the field operations in agriculture or horticulture conducted on the station farm need to be supplemented by similar work in a considerable number of localities in order to be of general usefulness to the State. In experiments with orchard fruits it is often better for the station to make arrangements to work in orchards already established. Special investigations of different kinds must be carried on away from the station in order to be of any use. By going into different localities, as the needs of its work demand, the station can make itself more useful to the State as a whole. Without doubt co-operative experiments need to be very carefully planned and thoroughly supervised to be successfully conducted, and their success depends on their quality rather than their number. It is encouraging to observe that more careful attention is being given to this important matter by station officers, and it is believed that this work may be made much more economical and useful than the permanent substations as ordinarily managed.

CO OPERATION OF THE STATIONS WITH THE DEPARTMENT OF AGRICULTURE.

As the stations and the various branches of this Department are working along similar lines, it has been found increasingly desirable for the Department and the stations to unite in co-operative enterprises, and this has been done to an increasing extent. This policy has been approved by the action of Congress, which in recent years has in an increasing number of instances authorized or directed co-operation with the stations in the appropriation acts making provision for the maintenance of this Department. These co-operative enterprises have so far increased in extent and variety as to make it desirable to have a more formal plan for arranging for such co-operation than has hitherto been necessary. In recognition of this need the Secretary of Agriculture made an order under date of February 28, 1899, requiring the officers of this Department to submit their plans for co-operation with the stations for his approval before negotiating with the stations, and designating the Office of Experiment Stations as the representative of the Department in arranging for such co-operation and keeping a record of the co-operative enterprises agreed upon. Under this order the Department and the station each designate the officers who are to have immediate charge of the co-operative work in any given case, and these officers carry out the details of the plan agreed upon. Recognizing the importance of this matter, the Association of American Agricultural Colleges and Experiment Stations, at its recent meeting in California, appointed a committee to confer with the Secretary of Agriculture on this subject and make a report to the Association at its next session.

The governing boards and executive officers of the stations feel the necessity of having the terms of co-operative operations definitely stated and the whole transaction made a matter of record as a component part of the station business. It is also desirable that ample opportunity should be given for the station to consider how far and in what ways co-operation with the department is desirable, and to what extent its funds will be involved in such co-operation. The stations are to an increasing extent becoming centers of information and authority on lines of work in which they have been engaged with special reference to the local requirements of agriculture, and it is by supplementing the funds already at the disposal of the stations for work in special lines, and by securing the services of their expert officers and the use of the special facilities at their command, that the Department can oftentimes accomplish results more economically and efficiently than by instituting parallel and independent investigations. As the operations of the stations become better organized in their respective localities, they have a just expectation that their knowledge of the local requirements of agriculture and their position as authorities on the subjects in which they work will be more fully recognized. By the union of these State institutions with this Department in the conduct of the larger enterprises for the promotion of agriculture in the United States, much more can be accomplished than by either agency working separately. The relations between the stations and this Department were never more cordial and intimate than they are now, and a relatively large number of co-operative enterprises have been undertaken during the past year on terms mutually satisfactory to the Department and the stations.

AGRICULTURAL EXPERIMENT STATIONS IN ALASKA.

The work in Alaska during the past year has included a continuation of the agricultural survey of this region and the inauguration of permanent experiment stations in accordance with the changed terms of the appropriation act of the current fiscal year. The results of our investigations and the accumulated evidence from other sources have, it is believed, sufficiently shown the desirability and feasibility of regular experimental inquiries for the promotion of agriculture in Alaska. With the completion and equipment of the offices, laboratories, and farm buildings at Sitka and Kenai, it will be possible to prosecute these inquiries much more efficiently. The establishment of headquarters for similar work in the interior, which, it is hoped, may be done the coming season, will make it possible to obtain more definite information regarding the agricultural capabilities of this region, which differs so materially from the coast region.

AGRICULTURAL EXPERIMENT STATIONS IN HAWAII, PUERTO RICO, AND THE PHILIPPINES.

The experiment station at Honolulu, in the Hawaiian Islands, maintained by the Hawaiian Sugar Planters' Association, has continued to be successfully conducted during the past year. It is hoped that advantage will be taken of the basis for experimental inquiries in agriculture in these islands thus laid by local enterprise, and that the United States Government will speedily supplement the efforts of the people of these islands in this direction as it has done in the States and Territories. Agricultural experiment stations should also be established without delay in Puerto Rico, and a plan should be made for their organization in the Philippines as soon as peace and order are established in those islands. In some respects legislation for the establishment and maintenance of agricultural experiment stations in the islands, under the control of the United States Government, should be wider in its provisions than the Hatch Act. Especially should provision be made for meeting the need of the people of those islands for immediate information regarding improved methods of agriculture which it is possible to give them, on the basis of the results of agricultural investigations already made elsewhere.

Any plan for experiment stations in Hawaii, Puerto Rico, and the Philippines should involve the following features: (1) A local station with land, buildings, and equipment for field and laboratory investigations; (2) an agricultural survey to study the agricultural capabilities and requirements of these islands; (3) co-operative experiments with resident farmers; (4) dissemination, under frank, of bulletins of original and compiled information in the language of the people for whom they are intended; and (5) the holding of farmers' meetings in different localities for the diffusion of practical information.

EXPERIMENT STATION EXHIBIT AT THE PARIS EXPOSITION OF 1900.

An exhibit designed to show the development and present status of the experiment station enterprise in this country has been prepared for the Paris Exposition of 1900 by a committee of the association of colleges and stations, of which Professor H. P. Armsby, director of the Pennsylvania Experimental Station, is chairman. The exhibit consists of a collection of special devices for station work and illustrations of notable results by means of models and otherwise, photographs and charts showing the buildings and equipment of the stations and special features of their work and their results, and the publications of the stations and of this office. In connection with this exhibit a comprehensive illustrated report on the history and present status of the stations has been prepared in the office of Experimental Stations with a view to showing what has been accomplished by the stations since their establishment, and the scope of this great enterprise on behalf of our agriculture as it exists at the close of the nineteenth century.

THE OFFICE OF EXPERIMENT STATIONS.

The work of the Office of Experiment Stations during the past year, as heretofore, has included the supervision of the expenditures of the stations; conferences and correspondence with station officers regarding the management, equipment, and work of the stations, and the collection and dissemination of information regarding the progress of agricultural investigations throughout the world by means of technical and popular bulletins. The special investigations on the nutrition of man and on irrigation assigned to this office have been prosecuted very largely in co-operation with experiment stations, educational institutions, and other agencies in the different States and Territories.

During the year the office issued 46 documents, aggregating 2924 pages. These include 13 numbers of the Experiment Station Record, with detailed index; 13 bulletins, 8 Farmers' Bulletins (including 5 numbers of the subseries entitled 'Experiment Station Work'), 3 circulars, 1 schedule, 3 articles for the Yearbook of the Department, the Annual Report of the Director, a report to Congress on the work and expenditures of the experiment stations, and 3 special articles published as separates.

The tenth volume of the Experiment Station Record comprises 1220 pages, and contains abstracts of 361 bulletins and 35 annual reports of 53 experiment stations in the United States, 172 publications of the Department of Agriculture, and 1224 rereports of foreign investigations. The total number of pages in these publications is 57,230. The total number of articles abstracted is 2023, classified as follows: Chemistry, 150; botany, 127; fermentation and bacteriology, 27; zoology, 23; meteorology, 46; air, water, and soils, 86; fertilizers, 109; field crops, 236; horticulture, 173; forestry, 34; seeds and weeds, 37; diseases of plants, 180; entomology, 202; food and animal production, 223; dairy, farming and dairying, 168; veterinary science, 86; technology, 6; agricultural engineering, 28; statistics, 82. Classified lists of articles, in some cases with brief abstracts are also given in each number. The aggregate number of titles thus reported is 1820.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation, under the act of Congress of March 2, 1887, in all the States and Territories. As stated above, agricultural experiments have been begun in Alaska with the aid of national funds, and an experiment station is in operation in Hawaii under private auspices. In each of the States of Alabama, Connecticut, New Jersey, and New York a separate station is maintained wholly or in part by State funds, and in Louisiana three stations are maintained with national and State funds. Excluding the branch stations established in several States, the total number of stations in the United States is 56. Of these, 52 received the appropriation provided for in the act of Congress above mentioned.

The total income of the stations during 1899 was $1,143,334.93, of which $720,000 was received from the National Government, the remainder, $423,334.93, coming from the following sources: State governments, $240,300.20; individuals and communities, $12,100; fees for analyses of fertilizers, $75,294.42; sales of farm products, $69,312.60; miscellaneous, $26,327.71. In addition to this the Office of Experiment Stations had an appropriation of $40,000 for the past fiscal year, including $10,000 for the Alaskan investigation. The value of additions to equipment of the stations in 1899 is estimated as follows: Buildings, $27,218.64; libraries, $10,796.15; apparatus, $16,917.07; farm implements, $10,784.88; live stock, $16,265.95; miscellaneous, $22,521.93; total, $104,504.62.

The stations employ 678 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 71; chemists, 148; agriculturists, 68; experts animal husbandry, 9; horticulturists, 77; farm foremen, 21: dairymen, 23; botanists, 52; entomologists, 48; veterinarians, 36; meteorologists, 17; biologists, 7; physicists, 7; geologists, 5; mycologists and bacteriologists, 20; irrigation engineers, 5; in charge of substations, 16; secretaries and treasurers, 24; librarians, 9; and clerks, 43. There are also 48 persons classified under the head of 'miscellaneous,' including superintendents of gardens, grounds, and buildings, apiarists, herdsmen, etc. Three hundred and eight station officers do more or less teaching in the colleges with which the stations are connected.

During 1899 the stations published 445 annual reports and bulletins. Besides regular reports and bulletins, a number of stations issued press bulletins, which were widely reproduced in the agricultural and county papers. The mailing lists of the stations now aggregate 500,000 names. Correspondence with farmers steadily increases and calls upon station officers for public addresses at institutes and other meetings of farmers are more numerous each year. The station officers continue to contribute many articles on special topics to agricultural and scientific journals. A number of books on agricultural subjects, written by station officers, have been published during the past year.

SCIENTIFIC BOOKS.

The Diuturnal Theory of the Earth. Published by MYRA ANDREWS and ERNEST G. STEVENS. New York. 1899.

This work belongs to a class usually not worth reviewing, but concerning which it is perhaps unwise to be absolutely silent. In this instance the earnest, well-meaning seriousness of the author, the abounding faith of the publishers, growing probably out of close family relationship, together with the absence of absolute impossibility or absurdity in the general doctrine advocated, fully justify a brief notice of the book. It is a well-printed octave volume of about 550 pages, and includes a portrait and a biographical sketch of the author.

Mr. William Andrews, the discoverer of the 'diuturnal motion of the earth,' was born in Philadelphia in 1798, and died at Cumberland, Md., where he had lived for half a century, on August 6, 1887. The preface to his book is dated 1876—and it was issued late in the year 1899. His business was that of a stationer and book binder, but his chief delight was in making geological and natural history collections, accumulating a 'museum' containing many thousand specimens. In this work he appears to have been successful and a portion of his 'museum' was purchased by the State of New York. The preparation of this work occupied much of his time during the later years of his life, but he also left manuscript essays on psychology and philosophy, the publication of which in the near future is promised.

That he was a great genius does not seem to be doubted by his biographer, Mr. E. S. Stevens, who declares that he was not only a great geologist, but also a great philosopher; that he was "the greatest scientist America has produced," that "he has left little to be accomplished," and that he has "taken his place beside Copernicus, Galileo, Newton and Darwin."

And what is the 'diuturnal motion of the earth' upon the conception and alleged proof of which so much claim to distinction is made to rest? No very clear account of it is to be found anywhere in the book, but it is obviously intended to mean a slow, progressive movement of the pole of the earth's axis of revolution in a spiral line around the earth's surface. Maps are given showing six lines of polar transmission across the Eastern and the Western hemispheres, and the period occupied in passing through one 'curl' of the spiral is assumed to be extremely great. This movement of the position of the earth's axis would necessarily produce great climatic changes, but in addition to this it is alleged that there would be a shifting of the superficial strata or crust of the earth relative to the interior, and upon this hypothesis is founded an explanation of existing geological phenomena, which, in the judgment of the biographer, 'transforms the patchwork of geology into a complete science.'

Among numerous illustrations of the author's fitness for discussing problems involving physical and dynamical laws, in which the book abounds, the following may be quoted: "Heat we claim to be material; it is substance and gravitates towards the center of the earth, constantly keeping an equilibrium between the interior forces and the external atmosphere, with its stratified fields of electricity and magnetism; but when that gravitated heat comes in contact with sedimentary deposits, containing a superabundance of compound substances, as vapors, gases and ethers, and liberates these through the action of the chemical processes in that great laboratory of nature, they must find their outlet through established chimneys, as volcanoes, or otherwise make new openings for their ascent to the upper air; and only in events like this would we be willing to attribute the phenomena called earthquakes to internal forces."

Speaking of Galileo the author says, "He discovered that the vibrations of all pendulums, even of different lengths were performed in equal time. * * * He also ascertained the beating of the pulse from this fact and counted it by the vibrations of a pendulum. * * * He discovered the thermometer, an instrument by which is measured the expansion or condensive heat of the atmosphere."

The author shows considerable familiarity with the literature of science, from which extensive quotations are made, often having little relation to the subject under discussion.

There is left with the reader a feeling of regret that those who have the means to contribute to the advancement of science by the issue of such expensive publications as this should not have sought competent advice from recognized scientific authority before going to the printer and book binder.

T. C. M.

Elements of the Differential Calculus. By James McMahon, A.M., Professor of Mathematics in Cornell University, and Virgil Snyder, Ph.D., Instructor in Mathematics in Cornell University. New York, Cincinnati, Chicago. The American Book Company. 1898. Pp. xiv + 337.

We have examined this book with pleasure. It was evidently composed in the light. Pedagogical and scientific qualities are united in a degree seldom attained in elementary textbooks. Sound argument, genuine demonstration, logical concatenation, are seen to be, in general, more consistent, than is commonly supposed, with required simplicity and clearness. The claims of the logician, on the one hand, and of the didactician, on the other, are adjusted with notable good judgment and skill. Illustrative solutions are numerous and the volume contains a plenty of suitable exercises for the reader, but the book is by no means a mere 'quarry of examples.' Even less, if possible, is it intended to be a guide to the mere practician. On the contrary, the treatment aims first of all at being scientific. The modern spirit prevails, a theory is presented, it is the understanding which is addressed throughout, and the student, if he be fit, will not easily escape the conviction, which not every elementary presentation of the calculus is good enough to produce, that he is dealing with a logically coherent body of doctrine, whose applications, moreover, yield absolutely valid results.

A good book points the way to its own improvement. We may, therefore, venture in course of the following remarks to indicate some respects in which what is well done may, in a second edition, be done perhaps even better.

Being confined to the differential calculus, the work possesses, on that account, some peculiar merits but fails, on the same account, to gain what many in recent years have come to regard as the very considerable advantages of presenting differentiation and integration simultaneously. Knowledge of some algebraic matters treated in the brief introductory chapter might, of course, have been defensibly presupposed; but as a precaution such preliminary review seems justified and would, perhaps, be even more acceptable were it more comprehensive. However, a certain fragmentariness and discontinuity of thought could have been avoided if the discussion of continuity, here begun, had been reserved for the next chapter where the discussion is resumed after an interval of twenty pages. From a statement of the properties which a function must possess if it is to be continuous in a given interval, the reader is left to infer what is meant by continuity 'at' and in the 'vicinity' of a point or a value. If the notion of continuity is very important, it is equally elusive, and as the beginner best learns what the idea is by learning what it is not, the authors' discussion, which is good, would have been enhanced, we believe, by a somewhat minute examination of at least several examples of discontinuity. The just observation, p. 11, that the 'essence' (of the infinitesimal) "lies in its power of decreasing numerically, having zero for its limit, and not in the smallness of any of the constant values it may pass through," seems to impose a restriction on the statement of theorem *2* on the following page and to invalidate the proof there given; for, of course, the sum of a finite number of infinitesimals may be constant, zero, while to speak of the 'largest' of the infinitesimals does not go to the 'essence' of the matter. The necessity of the word finite in the theorem is happily shown by examples, though definition of the term finite has not at this stage been attempted. The definition, later given, of finite number as being one which 'is neither infinite nor zero,' is, like that given by G. Cantor, not only negative (which is but a trifling objection) but also unavailable so long as the notion of the infinite is not formed. The infinite has, it is true, been defined as a variable but not as a constant. As constants, nevertheless, capable, moreover, of being 'given,' some infinites must be regarded, if, as in comparison of variables, the phrase 'infinite limit,' is to be recognized as legitimate, unless indeed one be prepared to reconstruct the idea of limit.

The notion of derivative, being attached by definition to that of continuous function, while it assumes the cardinal theorem that every function having a derivative is continuous, is, besides, not unlikely to prove a little bewildering to the student when a few pages later he is informed, without explanation, that some continuous functions do not possess derivatives. And being directed to "show that a function is not differentiable at a discontinuity," the student has only to reply that the function being discontinuous at a point is not continuous there, which is scarcely the answer expected. However, the imperfections noted relate mainly to minutiæ, they are histological imperfections and do not greatly mar the presentation as a whole, which, designed for the novice, is primarily concerned with the more obvious anatomy of the subject.

The chapter on fundamental principles is perhaps the best in the book, though some others, as those on expansion of functions and indeterminate forms, are specially worthy of praise. While no list of 'higher plane curves' has been inserted, there is a chapter on curve tracing and still another, unusually long but luminous, devoted to asymptotes. In dealing with the vexed and vexing question of the differential and the differential notation, the convenient though logically extraneous notion of 'rates,' is employed as sole medium of explanation. It would be interesting to have the term envelope, here presented in the usual way, so defined as to exclude all curves, such as the node locus, which are not properly tangent to curves of the family.

C. J. KEYSER.

COLUMBIA UNIVERSITY.

G. V. de Lapouge: l'Aryen: Son rôle social. Paris. 1899. 8vo. Pp. xx + 569.

The thesis of this work is that the tall, blond dolichocephalic race of the north of Europe has constituted the progressive and socially dominant element among the so-called Aryan peoples from prehistoric times to the present. In connection with the author's earlier work *les Selections sociales* (Paris, 1896), it is the best presentation of the results of the new school of anthropologists of which Lapouge and Otto Ammon are the leaders. If the results derived from the data now available are confirmed by wider investigation, they will obviously be of great significance for students of psychology, history and sociology, as well as anthropology. Further investigations ought now to be carried forward by individuals or institutions that have the means to prosecute them on an adequate scale.

CARLOS C. CLOSSON.

BOOKS RECEIVED.

Mesures électriques. E. VIGNERON et P. LETHEULE. Paris, Gauthier-Villars. 1900. Pp. 179. 2 fr., 50c.

Produits aromatiques. G. F. JAUBERT. Paris, Gauthier-Villars. 1900. Pp. 169.

La constitution du monde. CLÉMENCE ROYER. Paris, Schleicher Frères. 1900. Pp. xxii + 796.

Logic. ST. GEORGE STOCK. Oxford, B. H. Blackwell. 1900. Pp. xi + 440.

A First Book in Organic Evolution. D. KERFOOT SHUTE. Chicago Open Court Publishing Co. 1899. Pp. xvi + 285.

The Amateurs' Practical Garden Book. C. E. MUNN and L. H. BAILEY. New York and London, The Macmillan Company. 1900. Pp. vi + 250. $1.00.

Physiology. BUEL B. COLTON. Boston, D. C. Heath & Co. 1900. Pp. xiii + 386. 90 cts.

Syllabus of Elementary Physiology. ULYSSES O. COX. Mankato, Minn., Free Press Printing Co. 1899. Pp. viii + 167.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Geology, Jan.–Feb., 1900. Vol. 8, No. 1. 'Suggestions Regarding the Classification of the Igneous Rocks,' by William H. Hobbs. The article sets forth the present condition of the nomenclature and classification and offers many valuable suggestions, which if followed will certainly assist in extricating the science of petrology from the burden of names and complication of systems under which its students are now laboring. The importance of chemical composition in determining the classification of rocks and the use of diagrams to show the relations is emphasized.

'Dentition of some Devonian Fishes,' by C. R. Eastman. The dental characters of some species of the genera *Dinichthys*, *Clododus* and *Dipterus*, with comparative notes and illustrations of some types are discussed.

'Ancient Alpine Glaciers of the Sierra Costa Mountains in California,' by Oscar H. Hershey. The author describes in detail the characters of several of the ancient glaciers of this mountain range, and concludes from their study that they were probably of late Wisconsin age, and that they existed under the same climatic conditions as at present, but at an elevation of about 3000 feet higher than now.

'An Attempt to Test the Nebular Hypothesis by the Relation of Masses and Momenta,' by T. C. Chamberlin. In a comparison of the moment of momentum of the nebular system with moment of momentum of the present system, on the basis of purely mechanical laws, susceptible of mathematical computation, making every concession in favor of the Laplacian hypothesis, the nebular moment of momentum is 213 times larger than the present moment of momentum of the system, where the dynamic law would require them to be equal. Besides this very great discrepancy which is hard to explain on the Laplacian hypothesis, there are individual discrepancies among the planets of even greater significance. These range from 141 to 1 for the Jovian nebula to 1208 to 1 for the terrestrial nebula, with very great irregularity in the distribution from Mercury to Neptune. In the relation of the ratios of planetary masses to their momenta, it appears that Jupiter carried away one tenth of one per cent. of the nebular mass from which he separated, and 95% of the total momentum of the nebula. These same discrepancies occur also in the other planets with no apparent regularity. The present discrepancies can not be due to transfer of energy through tidal action. The computations show an irregular distribution of mass and momenta throughout the system which could not be derived by known laws under the nebular hypothesis, and so necessitates the construction of a new hypothesis which will give this unsymmetrical distribution. Some of the lines along which this new hypothesis may be sought are suggested. W. G. T.

American Chemical Journal, March, 1900. 'Anethol and its Isomers,' by W. R. Orndorff and D. A. Morton. 'The supposed Isomeric Potassium Sodium Sulphites,' by G. S. Fraps. It was found impossible to obtain the two sodium potassium salts of sulphurous acids which are theoretically possible, if the acid has the asymmetrical structure. 'Condensation Compounds of Amines and Camphoroxalic Acid,' by J. B. Tingle and A. Tingle. 'A Method for the Determination of the Melting-Point,' by M. Kuhara and M. Chikashige. The authors place the substance between a pair of thin coverglasses. These are held in a holder of platinum and inserted into a test-tube, which serves as an air-bath. 'The Symmetrical Chloride of Paranitro-orthosulphobenzoic Acid,' by F. S. Hollis. 'Stereoisomers and Racemic Compounds,' by H. C. Cooper.

THE March issue of *Terrestrial Magnetism and Atmospheric Electricity* contains the following articles:

The physical decomposition of the permanent magnetic field of the United States. No. 1. The assumed normal magnetization and the characteristics of the primary residual field, by L. A. Bauer and D. L. Hazard.

Die Aufgaben der erdmagnetischen Forschung der Vereinigten Staaten Nordamerikas, by L. A. Bauer.

Biographical sketch and portrait of the late Alexis de Tillo.

Einige Gesichtspunkte für die Einrichtung Erdmagnetischer Simultan-beobachtungen zur Erforschung der Ursachen der Erdmagnetischen Störungen, by Ad. Schmidt.

A comparison of the isogonic charts for the year 1900, issued by the 'Deutsche Seewarte' the United States Hydrographic Office, and the United States Coast and Geodetic Survey, by J. A. Fleming.

The United States Coast and Geodetic Survey: Its origin, development, and present status, by E. D. Preston. [Illustrated.]

Notes regarding magnetic instruments:

A source of error in the Kew magnetometer, by H. Morize.

The Coast and Geodetic Survey magnetometer, by L. A. Bauer.

The effect of glass covers in magnetic instruments, by E. G. Fischer.

The number concludes with 16 pp. of abstracts reviews, and notes on terrestrial magnetism and atmospheric electricity.

THE *Journal of the Boston Society of the Medical Sciences* for February 20th, opens with an article by H. G. Beyer, on the 'Relation between Mental Work and Physique,' in which the author arrives at the same conclusions as those reached by Dr. W. T. Porter, that precocious children weigh more and dull children less than the average of their age. C. S. Minot briefly describes 'A hitherto Unrecognized Form of Blood Circulation without Capillaries in the Organs of Vertebrates.' D. A. Sargent discusses 'The Relation of the Cephalic Index to Height, Weight, Strength and Mental Ability,' finding among eleven hundred Harvard students the brachycephalic were superior in scholarship and the dolichocephalic in athletics. W. H. Smith describes and figures 'Branching Tubercle Bacilli in Sputum,' and Harold C. Ernst gives a summary of a fully illustrated paper on 'The Development of the Microscope.'

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

A MEETING of the Section was held on Monday evening, March 5th. Professor R. S. Woodward gave an account of the Jubilee of Sir George G. Stokes, which he attended as a delegate from Columbia University. The Jubilee was held on the 1st and 2d of June, 1899, on the fiftieth anniversary of the professorship of Sir George G. Stokes at Cambridge. Stokes' most important work was done between 1842 and 1855. Among other things, he showed that in fluid motion the conditions under which the equations of motion were integrable were the conditions that the motion should be irrotational. He made researches in the elastic solid theory of light. He made advances in the theory of physical geodesy. He showed that the shape of the earth's surface should determine the law by which gravity varied from place to place. He cleared up a good many obscurities in the work of Fourier in regard to Fourier series.

The Jubilee began with the Rede lecture delivered by Professor Cornu, of the École Polytechnique, on the 'Wave Theory of Light,' and its influence on modern physics. Besides dinners, garden parties, etc., the most important ceremonies were the presentation of addresses by the delegates representing about seventy institutions, and the conferring of the honorary degree of Doctor of Science upon Messrs. Cornu, Darboux, Michelson, Mittag-Leffler, Quincke and Voigt. At the dinner which ended the celebration, Sir George Stokes made a speech in the course of which he said that he wished he had done more scientific work, but that if he had, he might not have been there to celebrate his Jubilee.

Mr. A. C. Longden read a paper on the resistance of thin films deposited by kathode radiation. He described his method of depositing thin films on glass and showed some specimens. These films can be used as high resistances instead of the very expensive wire resistances ordinarily used. Films of gold or platinum can be deposited, which have not the lack of durability of alloys. At the same time, unlike the metals in the form of wire, they have very low positive or even negative temperature coefficients. The films are deposited from a kathode of the same material by the discharge of electricity through a vacuum, and can be deposited in any thickness desired, and of any metal, gold and platinum being however the most convenient. The speaker showed a gold film of varying thickness in different parts, the thickest part showing the green color like gold leaf when viewed by transmitted light, and the color varying through blue to violet as the film became thinner.

At the suggestion of Mr. C. C. Trowbridge, Mr. Longden attempted to deposit a thin conducting film of selenium, but he was unsuccessful, as the film deposited was non-conducting. He obtained, however, a film of varying thickness which exhibited the phenomenon of Newton's rings in a beautiful manner.

An election of officers of the Section was held. Professor William Hallock was elected Chairman, and Dr. William S. Day, Secretary, for the ensuing year.

William S. Day,
Secretary of Section.

THE TORREY BOTANICAL CLUB.

At the meeting on February 18th, a paper was presented by Dr. H. H. Rusby, entitled 'The Tendency of Entomophilous Flowers to Antero-posterior Irregularity.' Its object was to show the distribution among plant-families of cases of such irregularity. Irregularities originating without reference to insect-pollination were classified and excluded. The irregularities considered and connected with insect-pollination, are not found among the 21 lowest of the 43 families of monocotyledons. Of the 10 next higher, 5 show none, 4 show slight or doubtful forms, while the highest, Liliaceæ, with 197 genera, twice as many as the other 9 families combined, shows, amidst general regularity, a few highly irregular genera, two of them simulating Orchidaceous forms. Of the 12 highest families, only 3 are regular. Five of the highest 6 are very irregular, indeed, the highest, Orchidaceæ, phenomenally so. It thus appears that an increased tendency to irregularity is indicative of higher development, but it is liable to occur in families and groups of families usually distinguished for its absence.

This principle was then shown to be even more clearly illustrated by the dicotyledons. In the 53 lowest families, but 4 show irregularity. Only one of these is found among the first 39, and this is Aristolochiaceæ, with a single irregular genus. Among the next 120 families, 27 show irregularity, and these are rather uniformly distributed among the others. Then come 19, several showing slight irregularity and one very irregular, indeed. The next 17 are, with one exception, highly irregular, one of them, however, being so in only a few of its genera. The 11 highest families are very peculiar. While mostly regular, some of them are noted for irregularity, but this is so peculiarly adjusted in the inflorescence as to bring about the condition of regularity so far as the latter is concerned. Thus the daisy, while an inflorescence, is essentially a regular flower, by virtue of the arrangement of its irregular florets. It is also noticeable that as these ray flowers are usually pistillate, this arrangement reverses the position, so far as the head is concerned, of the distinctively pistillate portion. The various types of irregularity in composite flowers were discussed, and these were contrasted with other families exhibiting radiant inflorescences.

It was pointed out that irregularity was not a fundamental characteristic, but was readily called into existence by the exigencies of any group, or even species, and might be expected to develop anywhere. Special attention was called, as illustrating this principle, to the marked irregularity of *Cotyledon gibbiflorum* and *Saxifraga sarmentosa*, species in notably regular genera. It was also noted as significant that the most irregular families, such as Leguminosæ, might have extensive series of genera perfectly regular; also that almost exactly equal forms of irregularity might develop in families most widely separated, as the Liliaceæ and the Capparidaceæ. The fact that irregularity is more frequent in the higher families of the two classes is due to the fact that an essential property of such families is a greater power of adaptation, floral irregularity being only one manifestation of this character.

Edward S. Burgess,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis of March 19, 1900, fifty-eight persons present, Dr. H. von Schrenk exhibited some burls on the white spruce (*Picea Canadensis*). The burls, unlike most of those so far known, are almost round, and are covered with smooth bark. They grow of various sizes, and occur on the trunk and branches of a group of spruces limited to a small area. The wood fibres are arranged in annual rings; they differ from normal wood fibres because of their thinner walls and greater internal diameter, giving the wood a spongy character. Long rows of secondary resin passages occur in each ring. The largest burls, which are from one to three feet in diameter, have rows of long holes within each ring. These holes are diamond-shaped in cross-section, the longer diameter extending radially. Between the holes the wood fibres are compressed tangentially. The speaker explained that the holes must have resulted from an excessive radial pressure exerted from without, probably by the bark. No holes were found where the bark pressure had been released, *i. e.*, where the bark had burst. These results are not in harmony with the findings as to bark pressure reached by Krabbe. The speaker described the manner in which burls are usually formed, and showed the way in which these burls form, by excessive growth, induced by a wound or branch stump.

Professor F. E. Nipher exhibited stereopticon slides made from a large number of photographic negatives which had been taken by the electric spark from a Holtz machine. The negatives show a complete picture of the object acted upon by the spark, and also show the electrical radiations in the field around the object photographed. The plates were greatly over-exposed to light before they were used. They were allowed to lie fully exposed in a well lighted room, for from one to nine days. One of the best negatives was developed from a plate thus exposed for nine days. The best results are obtained by darkening the room when the electrical image is produced. Light is found to counteract the electrical effects when their action is simultaneous and also when it follows the electrical exposure.

The pictures are developed in the dark room, by the light of an incandescent lamp. When the negative begins to fog, it is taken nearer to the lamp, and it at once clears up. All of these methods are in total disregard of all ordinary photographic procedure. The plates used are extra rapid, and the developing solution is that in common use in photography.

The result which is most interesting from a scientific point of view is shown on twelve negatives which reveal ball lightning effects. Ball lightning is to the electrician what the sea serpent is to the zoologist. It has often been seen, but never by those who are most competent to study and describe it, and all efforts to produce ball lightning effects by artificial means have hitherto failed. But these twelve negatives show with perfect distinctness discharges of this character. They could be seen while they were being photographed. They looked like little spheres of light, which traveled over a non-conducting plate, forming the insulation of a condenser. They traveled very slowly among the sparks of the ordinary disruptive discharge. Their speed was usually at the rate of an inch in three or four minutes. Their tracks showed with the greatest sharpness among the more indistinct flashes of miniature lightning. They sometimes jump for a quarter to a third of an inch, with such quickness that the eye can hardly follow them. Five or six such spheres of light sometimes appear at once, each following its own track. Sometimes one will cross a track previously traced by another, but it never follows the track of another.

By proper illumination of the room the effects of the spark discharges can be nearly obliterated in the negative, but the paths of the ball discharges are not materially affected. One negative thus treated had been exposed for thirty-five minutes, and the ball lightning tracks were most elaborate. The branching network of lines must have been produced by hundreds of these little spheres.

The same results can be obtained by fixing the negatives without any developing process. Everything then vanishes from the plate but the ball discharges.

Professor Nipher stated that this phenomenon could not be identified as the same thing as ball lightning, since the latter had not been studied. But it responds to the same description in many ways. As soon as the ball lightning effects appear, the behavior of the machine changes in a very remarkable way.

Mr. Koch exhibited an electrical fire annunciator.

Five persons were elected to active membership in the Academy.

WILLIAM TRELEASE,
Recording Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

AT the 515th meeting of the Philosophical Society of Washington, held at the Cosmos Club, March 17th, Mr. Abbe called the attention of the members to three interesting works in meteorology:

1. The work in theoretical physics, viz, the memoir of Professor Marcel Brillouin, explaining the formation of cloud and rain in accordance with the principles developed by Helmholtz and von Bezold. The full memoir is published by the Central Meteorological Bureau of France.

2. A work in experimental laboratory physics conducted by Mr. C. T. R. Wilson, showing how the condensation of aqueous vapor takes place by preference upon the negative ions and that such negative nuclei can be formed in the atmosphere by the action of various forms of radiation including the Röntgen Rays, the Uranium rays, sunlight, etc. That, finally, according to Professor J. J. Thomson, we must no longer regard the earth as primarily electrified negatively, and acting by induction upon the atmosphere to make it positive. We must regard the atmosphere as a mixture of neutral atoms and positive and negative ions; the latter being brought down to the earth's surface by rain make the earth negative while leaving the atmosphere positive.

3. A work of observation in the free air, viz: the Report of Professor H. Hergesell of Strasburg, published in the last number of the *Zeitschrift* of the German and Austrian Societies. In this report Hergesell presents isotherms, isobars and movements for sea level and at 5000 meters and, also, 10,000 meters elevation for three different dates, as deduced from 32 balloon ascensions, thus demonstrating the existence of the descending cyclones with cold centers first described by Ferrel. The three memoirs above mentioned were submitted for the personal examination of the members present.

Mr. L. P. Shidy read a paper on the State of Progress of our knowledge of the Tides, in which after briefly reviewing the steps by which our knowledge has been increased, he presented some of the views of Dr. R. A. Harris in regard to the tidal movements in the great oceanic basins. This mode of explanation of the tides, which has not yet been published, asserts that "In most cases the dominant ocean tides have their origin in definite systems whose free periods of oscillation are very nearly those of the tidal forces; and that the time of high or low water in each is the time when the virtual work of the tidal forces upon the system becomes zero." The time and height of the tides in Lake Superior and the eastern portion of the Mediterranean Sea, as computed by the corrected equilibrium theory, were found to agree with observations quite well. A number of localities forming fractional areas having dependent stationary waves were enumerated, the tides in the Gulf of Suez and in the Gulf of Maine being selected as examples which were somewhat fully explained.

Mr. L. A. Bauer then exhibited a number of lantern slides showing photographs of distinguished men in the line of Meteorology and Magnetism. A number of views of noted magnetic observatories were also given. On account of the lateness of the hour Mr. Bauer was obliged to omit a descriptive paper which he had prepared on the subject.

E. D. Preston,
Secretary.

DISCUSSION AND CORRESPONDENCE.

ELECTRICAL UNITS AND THE INTERNATIONAL CONGRESS.

In Mr. Wolff's interesting article on the 'Electrical Standards of the Office of Weights and Measures (Science, March 16, 1900), there is an unjustifiable criticism (unintentionally so, I have no doubt) of the work of the International Congress of 1893, in defining the three fundamental units.

A careful reading of the official report of the Chamber of Delegates will show that a special effort was made to avoid the error which Mr. Wolff thinks the Congress committed. As the official Proceedings include little of the discussion which occurred during sessions lasting nearly a week, a brief reference to the history of these definitions may be useful. A large part of one of the early sessions was spent in discussion, which almost became controversy, of the definitions of the ohm, ampere and volt. A set of definitions was submitted by the American delegates which were *primarily* rigorous, essentially those of the British Association Committee, the material representations being defined as approximations. The idea was to adopt definitions which in themselves would never need revision, leaving the way open, however, to any better approximations in material standards that might be possible in the future. These definitions were advocated by the American and English delegates, but they were opposed by the German and French members of the Chamber. At the end of the day it looked as if the Chamber might not be able to come to an agreement upon even the fundamental units, and to avoid so unfortunate an issue a Committee consisting of Messrs. Von Helmholtz, Mascart, Ayrton and Mendenhall, with the President of the Chamber, Professor Rowland, was appointed to bring in a report defining the ohm, ampere and volt at the next session.

This committee reported on Thursday, August 24th, and its conclusions, which were unanimously adopted by the Chamber, became the basis of all subsequent work.

It will thus appear that the definitions of the fundamental units as issued by the International Congress were not exactly what the American and English delegates would have chosen, but some sort of a compromise was necessary in order to avoid a failure. Care was taken, however, to see that there was really no inconsistency or absurdity present or possible in the language used. The ampere is said to be '*represented sufficiently well for practical use by, etc.*,' and in the definition of the volt the same phrase occurs so that the ampere is *not* declared to be a current of a certain silver depositing power, nor is the volt declared to be a certain fraction of the E. M. F., of a Clark cell. A variation of the same language is used in defining ohm but it was found impossible to get exactly the same words in. When, in 1894, Congress enacted a law legalizing these units, a few slight verbal changes were made without altering the meaning.

T. C. M.

NECTURUS MACULOSUS RAFINESQUE IN THE LOWER DELAWARE RIVER.

In the *American Naturalist* for 1892, pp. 779 and 780, Mr. W. B. Marshall gives an account of 'Necturus maculatus in the Hudson River' in which he calls attention to the fact that no record is known to him of its inhabiting the Delaware River, though he presumes that it may probably be found there at some future time. I am very glad to justify his statements with the fact that I have received a mature living specimen for examination that was taken in Darby Creek, which is a tributary of the Delaware River and into which it empties several miles below Philadelphia. The precise locality was near Essington and the date of capture March 2d. When captured, being taken in a small cast net, it was said to have emitted a cry very much resembling that made occasionally by frogs when taken in the hand. The animal has now lived a week in captivity and has been feeding almost entirely on small fish and tadpoles. It seems particularly fond of the common Mud Minnow (*Umbra pygmæa*) and various small Sunfishes (Centrarchidæ), of which it has consumed about fifty or more. By the occurrence of this species in the lower Delaware, where, it would seem, it found its way from the Hudson River by means of the Delaware and Hudson canal, which connects the two rivers at Port Jervis and Kingston, it has enlarged its geographical distribution through the unintentional aid of man. Most likely the occurrence of other aquatic animals, indigenous to the western part of New York, that have or might be found in the Delaware basin, have reached the latter through the same means, as the Erie canal connects the Hudson with many of the streams of western New York.

Henry W. Fowler.

LAMPREYS IN CAPTIVITY.

Very small (6 mm.–8mm.) Ammocœtes larvæ are quite delicate, and it was only by the exercise of the greatest care that they were kept alive, in aquaria, for a period of six weeks.

Older larvæ (10 cm.–15 cm. in length), on the other hand, are remarkably hardy, and may be kept alive indefinitely in small aquaria of running water. It is not even necessary to have a constant changing of water. Sand should be placed in the aquaria, in which the larvæ may bury themselves.

The adult lampreys are moderately hardy and may be kept in small tanks of running water without difficulty. By catching a number of the adults, in the spring, as they are passing up the rivers to the spawning grounds, and keeping them in captivity until sexual maturity is reached, it seems probable that artificial fertilization may easily be accomplished and embryological material thus obtained.

Albert M. Reese.

Johns Hopkins University.

NOTES ON PHYSICS.

THE RATIONALISM OF ELECTRICAL UNITS.

Present electrical units are irrational in that the factor 4π does not appear in certain equations where it would be proper for it to appear, while in other equations this factor does appear improperly. The British Association Committee on Electrical Standards fixed for us the present definitions of the units of magnetism and of electric charge when they published in one of their reports the little treatise on units by Maxwell and Jenkin. In this treatise the factor 4π is suppressed for the sake of simplicity and the result is that we have an 'eruption of 4π's' in other quarters. This eruption is due, literally, as Heaviside puts it, to the wisdom of our ancestors, who, according to the same witty sage, were sufficiently wise in their generation.

Several proposals have recently been made looking to the rationalization of our electrical units. The complete solution of the difficulty, according to the wisdom of the present generation, is proposed by Heaviside. This proposal involves great changes in the magnitudes of all electric and magnetic units—a very serious matter.

Professor Fessenden proposes an ingenious solution of the difficulty which involves no important change in any of the units which are used by engineers. Professor Fessenden's solution does not, however, completely rid us of the irrational appearance of the 4π factor, and if this solution were to be adopted by us, our posterity might still suffer by our wisdom.

On the whole this eruption of 4π's is not a very serious matter, and it is not likely that an international congress will soon take steps to rid us of it.

On the other hand there are some points of advantage in our present definitions of *magnet pole* and *electric charge.* It is all very well to talk of defining electric current, as the curl of magnetic force and of magnetic current as the curl of electric force, indeed it is very simple to think in this way when one has once abstracted his knowledge of electrical things sufficiently to make the images of these things meet—but how about the beginner?

Such things as force, temperature and electric current are measured by their effects. For example force may be measured by its distorting effects on elastic bodies or by its effect in changing the state of motion of a body. One of the most evident effects of a magnet pole is its attraction for other poles and the present writer knows of no simpler way to establish a quantitative basis for the discussion of magnetism than to agree at once to measure a magnetic pole in terms of its attraction for a unit pole, the unit pole being that pole which repels an equal pole at unit distance with unit force. Then the force of attraction of any two poles is $F = \frac{m'm''}{d^2}$. Now it leads eventually to simpler equations to so define the unit pole that $F = \frac{m'm''}{4\pi d^2}$ but the present writer, for one, would have some hesitation in presenting the matter to a class in this initially more complicated way with no other excuse than that a certain remote advantage will come of it. Perhaps the present writer, who finds his greatest trials in teaching, is unreasonably timid.

The most valid objection, however, to the present recasting of our systems of electrical units—for we are at present burdened with two systems, not including the entirely useless practical system—is that we have no assurance that a new system would stand. For, in the first place, a new electrical relation must be discovered before we can settle upon *one* system of units; and in the second place we do not know even whether electric current and curl of magnetic field are identical or merely proportional, as has been pointed out by J. J. Thomson.

W. S. F.

SCIENTIFIC NOTES AND NEWS.

On the occasion of the bi-centenary celebration of the Academy of Sciences at Berlin, Lord Kelvin and Professor Max Müller were elected foreign members. Professor Willard Gibbs, Professor H. A. Rowland, and Professor William James were among those elected Corresponding Members.

The marble statue of Huxley, which the Memorial Committee has given to the Natural History Museum at South Kensington, will be unveiled on April 28th. It is expected that Sir Joseph Hooker will make an address on Huxley, and that the statue will be received by the Prince of Wales on behalf of the trustees of the British Museum.

President Gilbert of the American Association for the Advancement of Science has authorized a meeting of the Council at the Assembly Hall of the Cosmos Club, Washington, D. C., at 4:30 p. m., on Thursday, April 19th.

Dr. Wm. Luther has been appointed director of the observatory at Düsseldorf, in succession to his father, Dr. Robert Luther, whose death we were recently compelled to record.

Professor S. W. Johnson has resigned the directorship of the Connecticut Agricultural Experiment Station after service of over twenty-two years, and is succeeded by Professor E. H. Jenkins, the vice-director.

Professor Silas W. Holman, emeritus professor of physics at the Massachusetts Institute of Technology, died on April 2d.

Professor St. George Mivart, the well-known writer on scientific subjects, died in London on April 1st, at the age of seventy-three years.

There died recently Major Fred. Mather, one of the most prominent of American fish-culturists. He was the author of many notable contributions to the Reports of the Fisheries of State and Government, long time an assistant of the U. S. Fish Commission, indeed one of its originators. He was the inventor of several valuable forms of fish-hatching apparatus, especially for the treatment of adhesive eggs, and of the well-known 'refrigerating box' by which he solved successfully the problem of transporting fish-spawn across the ocean. He was several times employed on foreign missions connected with the fisheries. Under the N. Y. State Fish Commission he established the station at Cold Spring Harbor, and directed its operations for nearly fifteen years. He will also be remembered in themes of fish and fishing as a popular writer of rare talent. Born near Albany, N. Y., in 1833, he died at Cedar Island, on the Brule river, Wisconsin, on February 14th.

Dr. Emanuel Liais, the astronomer, has died at Cherbourg at the age of seventy-four years.

The death is announced of Professor John Henry Pepper, an analytic chemist and public analyst in Brisbane, Queensland, at the age of 79 years.

Professor G. E. Morrow died, on March 27th, at the age of 60 years. He was for about 20 years professor of agriculture in the University of Illinois.

Dr. Zukal, associate professor of botany in the Agricultural Institute at Vienna, died on the 15th of February, aged 55 years.

By the generosity of Mr. William H. Crocker, of San Francisco, the Lick Observatory will be able, as we announced last week, to send a party to Georgia, to observe the total solar eclipse of May 28th. Only two observers, Messrs. W. W. Campbell and C. D. Perrine, will be sent out from the observatory; but several European astronomers have expressed a desire to join the party, and similar requests have also been received from astronomers connected with American colleges, which do not intend to send out expeditions of their own. The instrumental equipment of the expedition will be quite complete. The principal instrument for photographing the corona will be the 5-inch telescope of 40 feet focal length, used by the Lick Observatory parties in South America and India. For photographing the corona on a smaller scale there will be several cameras of from five to six inches aperture, and others of smaller size. One slit spectrograph, and two objective spectrographs arranged to give a continuous record of the changing spectrum at the beginning and end of totality, are also included in the equipment. Observations of contacts will be made. Any observers, having experience in astronomical or physical work, who wish to join the party at their own expense, like the gentlemen referred to above, are invited to communicate with the Director of the Lick Observatory before April 20th, and after that date with Professor W. W. Campbell, Lick Observatory Eclipse Expedition, Atlanta, Georgia.

Since September, the collections at the Gray herbarium of Harvard University have been increased to the extent of several thousand specimens from various parts of the world. Among the acquisitions is a collection of Central American plants, 875 in number, presented by Captain J. Donnell Smith, of Baltimore. Another, consisting of some 900 specimens, has come from Puerto Rico. The United States Department of Agriculture has sent 621 specimens of American grasses, the botanic garden of the University of Vienna, 877 Austrian plants, and the New York botanical garden, 561 plants from Idaho and Montana. In addition, 852 specimens from the Galapagos Islands have been received for the purpose of critical study. The staff is giving considerable attention to the continuation of the Synoptical Flora of North America, begun by Dr. Gray, and now being edited by Professor Benjamin L. Robinson. The usual amount of research work is in progress. Among those engaged in it are Professor Piper of the Washington Agricultural College and Professor Henderson of the Idaho Agricultural College, who are studying the type specimens of Western plants in the herbarium.

A civil service examination will be held on April 17th to 18th to fill two vacancies in the position of cartographic draftsman in the Hydrographic Office, Navy Department.

A New York State Civil Service examination will be held on or about April 18th for the position of electrical engineer, with a salary of $900 and maintenance; and for the position of physician in the State Hospitals and Institutions, with a salary of $600–$900 and maintenance.

We learn from the *Annals of the Deaf* that at the public session of the French Academy held November 24, 1890, Mr. Ferdinand Brunetière announced that the Montyon prize of $400 had been awarded for that year to Mrs. Marie Germaine, in religion Sister Sainte-Marguerite of the Daughters of Wisdom, for the successful education of two deaf-blind girls, Marthe Obrecht, who lost sight and hearing at the age of four, and Marie Heurtin, who was deaf-blind from birth. Both these girls had been taught to read, write, speak, and work.

The Council of the Royal College of Surgeons of England has appointed a Committee to adjudicate on the Walker Prize. This prize, which is open to investigators of all nationalities, is given for the best work in advancing the knowledge and therapeutics of cancer during the past five years ending December 31, 1900, and amounts to the sum of £100.

Mr. George Eastman, of Rochester, N. Y., has given $200,000 to the Mechanics Institute of that city. The money will be used to enlarge the present building.

The Baroness von Hirsch-Gerenth, who died recently, has bequeathed 50,000 francs for the establishment of a physiological and pathological laboratory on the Congo. Leopoldsville, the terminus of the Congo railway, has been chosen as the place where the laboratory is to be established.

It is proposed to introduce a bill into Congress appropriating $250,000 for the establishment at Paris, of an American Institute for the study of the fine arts. The plan has been presented to President McKinley by Ambassador Chambon and Senator Depew, and is said to have the approval of the Secretary of State. If the Government were to support institutes for applied science in foreign countries they would doubtless more than repay their cost.

The late Governor J. G. Smith has left $10,000 for a library at St. Albans, Vt.

The second malarial expedition, promoted by the Liverpool School of Tropical Medicine, left Liverpool on March 21st in the steamship *Olenda* for Old Calabar and South Nigeria. The object of the expedition is to study the cause, spread and the treatment of malaria and tropical diseases generally. The expedition consists of Dr. H. E. Annett Elliott (Toronto) and Dr. J. E. Dutton. Investigations and experiments will be made in accordance with the mosquito theory of Major Ross. In encouragement of the expedition the Colonial Secretary wrote expressing his appreciation of its objects, and said that he would do all in his power to secure the assistance of government officials in the West African settlements.

A cablegram has been received from Wellington, New Zealand, stating that the *Southern Cross* reached that city on April 1st. The Expedition, fitted out by Sir George Newnes and headed by Mr. C. E. Borchgrevink, sailed from London in August, 1898, and left Hobart, Tasmania, December 19, 1898. During the latter part of February the members landed from the *Southern Cross*, near Cape Adare, Victoria Land, on the Antarctic Continent. Mr. Borchgrevinck reports that he has found the position of the southern Magnetic Pole. Mr. N. Hansen, one of the zoologists of the expedition, died on the voyage.

The London *Times* gives some further details in regard to the Scottish-Antarctic expedition about to be organized to work in conjunction with the British and German Antarctic expeditions. It fills up a gap in the Antarctic regions, which neither the British expedition at present being organized by the Royal and Royal Geographical Societies of London nor the German national Antarctic expedition intends to explore. The Weddell sea quadrant, south of the Atlantic Ocean, will be the sphere of the Scottish expedition, while the British expedition will explore to the south of the Pacific Ocean and the Germans to the south of the Indian Ocean. This Weddell sea route, it may be mentioned, has been taken before by Weddell, Bellingshausen, and Ross in sailing ships, but has not yet been tried seriously with a steamer. The leader will be Mr. William S. Bruce, who visited the Antarctic regions in 1892 and 1893, and who has since made five voyages to the Arctic regions. It is intended that the expedition should return in 1903, but if funds hold out, a year later.

The annual Field Meeting or long distance excursion of the National Geographic Society has been arranged so that the members of the Society may have an opportunity to observe the total eclipse of the sun, which takes place on Monday, May 28th. As the center of the belt of totality will pass near Norfolk, Virginia, the board of managers of the Society have made a conditional contract with the Norfolk and Washington Steamboat Company for an excursion to that city and vicinity. The party will leave Washington by the Norfolk and Washington steamer at 7 o'clock, p. m., Sunday, May 27th. Returning, leave Norfolk at 6 o'clock Monday afternoon, reaching Washington on Tuesday morning in time for breakfast at home. The total duration of the eclipse will be 2 hours, 34 minutes and 6 seconds, of which 1 minute and 26 seconds will be total. The eclipse will be entirely over at 10:15.6 a. m., and from that hour until 6 o'clock the steamer will be at the disposal of the party for a cruise around the harbor and visits to the many points of interest around Norfolk, such as the Navy Yard, Portsmouth, Newport News, Fortress Monroe, the Indian Industrial School at Hampton, etc.

The first volume of the scientific results of the Norwegian Polar Expedition, edited by Dr. Fridjof Nansen, is about to be issued by Messrs. Longmans, Green & Co. In addition to an account of the *Fram* by Mr. Collin Archer, the builder, the volume contains memoirs on the geology of Cape Flora in Franz Josef Land, by Dr. Pompeckj and Dr. Nansen; the fossil plants from Franz Josef Land, by Dr. A. G. Nathorst; the birds collected during the expedition, by Mr. Collett and Dr. Nansen; and the crustacea, by Professor G. O. Sars. It is expected that five or six volumes in all will be published.

The Croonian Lecture before the Royal Society will be delivered on March 22d by Professor Paul Ehrlich. The subject of the lecture will be Immunity, with special reference to cell life.

The Institution of Civil Engineers, London held its annual dinner on March 21st. Sir William Preece presided, and speeches were made by Lord Ashbourne, Lieutenant General Geary, Lord Welby and Lord Balfour of Burleigh. Sir William Preece stated that arrangements had been made to entertain American visitors at the Guildhall on July 5th.

The Annual Report of the Director of the Field Columbian Museum for the year 1898–99 shows a steady increase of the material in its various departments, most noticeable perhaps, in the way of fossil vertebrates, some fine specimens of the large Dinosaurs having been obtained in Wyoming. Good progress has been made in the Department of Anthropology, while the herbarium is now considered the best in the Central United States. While there has been a slight falling off in the total attendance, yet many more school children have visited the museum than ever before, and the courses of lectures have been deservedly popular. The report is illustrated by a number of plates showing some of Mr. Akeley's fine mammal groups and some of the anthropological exhibits, as well as a view of a remarkably fine skull of *Titanotherium*, considered as *T. ingens*.

The following letter has been addressed to Sir Michael Foster on the occasion of his entering Parliament by a number of his former pupils at Cambridge.

We, a few of your Cambridge friends, take the opportunity given by your entering Parliament to express our loyalty, respect, and cordial friendship towards you. Though we regret anything which takes you from among us, yet we cannot but rejoice that the cause of learning has gained so strong an advocate in Parliament. The work you have done in Cambridge during the last 30 years seems to us of unique value. You have taught us to recognize what is worth learning, and you have taught us how to learn. If we in Cambridge now value and seek after the advancement of natural knowledge, we owe it to you more than to any man living. We beg you to believe that we are grateful, and we shall rejoice if we can in any way prove our sincerity. We can ill afford to lose either the weight of your name or your guidance at our councils; we can, indeed, hardly imagine a greater misfortune than the breaking of the bond between you and us. But we cannnot complain if, after many years of service, you have found it necessary to loosen your official ties to the University. We regret that your enlarged liberty has not come to you in a form which would have marked our sense of what we owe to you. But we rejoice that an arrangement has been arrived at which will allow your interests still to centre in Cambridge, giving you, at the same time, the opportunity of working in a wider field, where you may do for England what you have already done for Cambridge, and where your services to learning may benefit, not only England, but the whole English-speaking race.—We are proud to sign ourselves your friends and pupils—Francis Darwin, A. G. Dew-Smith, Walter Gardiner, W. H. Gaskell, Alfred C. Hadden, W. B. Hardy, S. F. Harmer, Walter Heape, J. N. Langley, J. J. Lister, A. Sedgwick, A. C. Seward, Arthur E. Shipley, L. E. Shore, H. Marshall Ward, H. K. Anderson, A. S. Lea. March 9, 1900."

The *British Medical Journal* states that a Medical Congress of the Island of Cuba is now being organized. It is to be held at Havana, and will open on February 24, 1901. The president of the organizing committee is Dr. Vicente B. Valdés. The subjects with which the Congress will deal in are the following: (1) Local Anthropology; (2) Medical Topography and Statistics; (3) Yellow Fever; (4) Paludism; (5) *Biebre de borras;* (6) Chronic Enteritis of Hot Countries; (7) Febrile Conditions of Infancy which do not correspond to Definite Clinical Types; (8) Treatment of Pulmonary Phthisis by Local Climatotherapy; (9) Medical Hydrology of Cuba; (10) Therapeutic Uses of some Indigenous Plants.

The New York *Evening Post* states that the scientific museum of Princeton University has received a collection of Indian pottery, stone axes, and articles used in religious ceremonies of the Hopi Indians of Arizona. This gift is the first installment of a series from Stanley R. McCormick, '95. The present collection consists very largely of pieces of recent manufacture, which represent the methods of modelling and decoration employed by this tribe of Indians. This McCormick collection will have special value as supplementing the large collections already possessed of Mexican and Peruvian pottery and the extensive Sheldon Jackson ethnological collection from Alaska and New Mexico.

An exhibit from the United States Patent Office has been sent to the Paris Exposition. It is confined to models representing the applications of electricity to which American inventers have contributed so much. There is a law forbidding the taking of models of patents from the country, but a special Act of Congress was enacted permitting it in this case. This was accomplished, however, so late as to interfere somewhat with the completeness of the exhibit.

UNIVERSITY AND EDUCATIONAL NEWS.

Dr. Henry S. Pritchett, Superintendent of the U. S. Coast and Geodetic Survey, has been elected president of the Massachusetts Institute of Technology.

The Maryland Legislature has voted against the continuation of an annual appropriation to the Johns Hopkins University.

Sir William C. MacDonald has made a further gift of $200,000 to McGill University for the work in mining and chemistry.

Merton College, Oxford, has offered to contribute, out of its University Purposes Fund, £700 towards the cost of fitting up, and £500 towards that of maintaining for two years, a new electrical laboratory.

The New York *Evening Post* states that the sophomore class, of Yale University, which by the catalogue of this year contains 305 students, has made choice of studies under the new elective system as follows: Greek has been chosen by 124, Latin by 203, chemistry by 48, physics by 202, English by 259, French by 117, German by 178, history by 202, and mathematics by 159. It will be remembered that last year the members of the sophomore class were required to elect five of six subjects. This year additional electives in chemistry, history, modern languages, and mathematics have been provided.

A chair of intertropical pathology has been established in the University of Havana for Dr. J. Guiteras, formerly professor of pathology in the University of Pennsylvania.

Professor Jacques Loeb, of the University of Chicago, has been appointed professor of physiology in the Rush Medical College, recently affiliated with the University. It is understood that the junior work in physiology will be carried out at the University of Chicago.

SCIENCE

FRIDAY, APRIL 13, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE GEOLOGICAL AND FAUNAL RELATIONS OF EUROPE AND AMERICA DURING THE TERTIARY PERIOD AND THE THEORY OF THE SUCCESSIVE INVASIONS OF AN AFRICAN FAUNA.**

SEVERAL years ago the discovery of some new types of Rhinoceroses in this country directed my attention afresh to the study of the Tertiary fauna of Europe as parallel with that of America. In the succession of European and American types it appeared that there were most interesting similarities between rhinoceroses as widely separated as the present regions of Colorado and Southern France, but upon attempting more than a general comparison I was confronted by a lack of definite time scale between the levels in which these animals occur. The available correlations by Cope, Filhol, Scott, Zittel and others proved too indefinite at certain points. This difficulty became so obstructive that a more exact correlation of European and American horizons appeared to be an essential basis not only for the phylogeny of the Rhinoceroses but for that of other types of mammals of Europe and North America.

STRATIGRAPHICAL CORRELATION.

In an address before the Academy last year the various steps which have been taken to secure such correlation were described. The work proves to be a very diffi-

*Address of retiring President, New York Academy of Sciences, February 26, 1900.

cult one and is by no means complete. The kind co-operation of the leading paleontologists of Europe was enlisted and as a result an approximate correlation sheet was prepared. This was virtually a report of progress in this investigation, main emphasis being laid upon geological succession. In continuing the subject this year, main emphasis will be laid upon *faunal* succession or the distribution of the different orders and families of mammals, concluding with the latest views as to the succession of life during the Pleistocene period in Europe.

I

LYELL'S SYSTEM			Approximate American Parallels
PLEISTOCENE	UPPER	Post Glacial & Recent	
	MIDDLE	Glacial & Interglacial	
	LOWER	PREGLACIAL	?EQUUS BEDS
PLEIOCENE	UPPER	SICILIEN	? BLANCO
	MIDDLE	ASTIEN	
		PLAISANCIEN	
	LOWER	MESSINIEN	Upper Loup Fork
MIOCENE	UPPER	TORTONIEN	LOUP FORK
	MIDDLE	HELVETIEN	Lower Loup Fork AND
	LOWER	LANGHIEN	Upper John Day
OLIGOCENE	UPPER	AQUITANIEN	Lower John Day (Diceratherium Layer)
	LOWER	STAMPIEN	WHITE RIVER
		INFRA. TONGRIEN	
EOCENE	UPPER	LIGURIEN	BRIDGER & UINTA
	MIDDLE	BARTONIEN	LOWER BRIDGER
		LUTETIEN	WIND RIVER
	LOWER	SUESSONIEN	WASATCH
	BASAL	THANETIEN	TORREJON
		MONTIEN	PUERCO

CHART I.—Preliminary Correlation Table of European and American Tertiary Horizons. On all the levels above the Stampien the parallels are imperfectly established.

The preliminary correlation sheet abbreviated in Chart I. sets forth the results of the geological succession and correlation so far as it has been carried at present and illustrates the rapid progress of our knowledge of our own horizons. It includes the latest results of the American Museum explorations in the Miocene of Colorado and Kansas, as roughly studied by Matthew, but these correlations are not to be understood as final. Scott has already transferred our John Day of Oregon, from the Miocene, where it was formerly placed, to the Upper Oligocene. The lower part at least of these beds belongs in the Oligocene—while the Upper John Day may prove to correspond with the Lower Miocene of Europe. Our Pliocene record as compared with the magnificent Pliocene of Europe is extremely meagre and our Miocene succession rich as it is, is not as fully understood as the Miocene of France. We look for more exact results from the American Museum explorations which are now being collated. It is only when we pass into the great time period from the Oligocene downwards that the American record becomes a superbly complete time standard for the whole Northern Hemisphere or Holarctic Region.

TERTIARY GEOGRAPHICAL DISTRIBUTION.

The importance of geographical distribution was first recognized by Humboldt, and set forth by Darwin in the 'Origin of Species,' in 1858. In the same year Sclater divided the world into eastern and western divisions or Palaeogæa and Neogæa, to embrace the Old and New Worlds respectively, a division which has proved to be totally illogical. This led Darwin's distinguished colleague, Alfred Wallace, to his great work upon the 'Geographical Distribution of Animals' and the division of the world into life regions; in which Sclater's scheme was adopted and developed.* In 1868, Huxley divided the world into a northern division, Arctogæa, and a southern division Notogæa to include the Northern and Southern Hemispheres respectively; this division was a little nearer the truth than Sclater's. Between 1868 and 1890,

* The history of opinion upon this subject is fully set forth by Lydekker's invaluable work the 'Geographical Distribution of Mammals,' published in 1896.

Sclater, Allen, Newton and Blanford, working upon living birds and mammals, continued this investigation, but it remained for Blanford, in 1890, to prove that the world zoologically should be divided into three great divisions; an Australian, a South American and a third region, Arctogæa, comprising North America, Europe, Asia and Africa.

Now it is clear that exactly as our understanding of the relations of living animals and plants to each other depends upon their fossil ancestors or upon their paleontology, so the final test of a scheme of zoological distribution must be a paleontological test. The animals of various families and orders have either originated in or migrated into their present habitat in past time, so that the geological record as to their order of appearance becomes of first importance. Here again the necessity of an *absolutely reliable correlation time scale* such as we are now establishing becomes evident, for the very first step toward an exact solution of the problem of past migration is to establish, as far as possible, the faunal parallels upon different continents, we can then determine where certain types of animals first appeared, and distinguish between the autocthonous endemic or native types and the migrant or new types.

This then is our problem, to connect living distribution with distribution in past time and to propose a system which will be in harmony with both sets of facts.

The tests of synchronism between European and American depositions are fourfold: First, the presence of a number of identical or closely allied genera and species. Second, similarity in the steps of evolution in related animals. Third, the predominance and spread of certain animals, as of the odd-toed Ungulates in the middle Eocene and of the even-toed Ungulates in the Upper Eocene. Fourth, the sudden appearance of new types which have apparently originated elsewhere and have enjoyed an extensive migration, so that they appear simultaneously in different regions of the earth. An instance of this kind is afforded by the unheralded appearance of new types in the base of the Oligocene (Rhinoceroses) and of the Miocene (Proboscidia) in Europe and America.

Unfortunately there is still no agreement among zoologists as to the faunal geographical divisions. Lydekker, well versed in both paleontology and zoology, has for the first time brought together both classes of evidence in his recent valuable work upon the 'Geographical Distribution of Mammals'; he shows conclusively that zoopaleontology favors the division of the world into three great realms as proposed by Blanford, to these may be applied the terms Arctogæa, Notogæa and Neogæa, as proposed anonymously in 1893. (Chart II.)

Geographically, these realms are connected by low lying portions of the earth, which, during long periods of submergence beneath the sea, have completely isolated them. At the same time we are forced to conclude that there were shorter intervals of elevation or land continuity at various times during the Tertiary period.

Now it is a well-known principle of zoological evolution that an isolated region, if large and sufficiently varied in its topography, soil, climate and vegetation, will give rise to a diversified fauna according to the *law of adaptive radiation** from primitive and central types. Branches will spring off in all directions to take advantage of every possible opportunity of securing food. The modifications which animals undergo in this adaptive radiation are largely of mechanical nature, they are lim-

*So termed by the writer, see 'Rise of Mammalia in North America,' 1893, and 'Origin of Mammals,' 1898.

ited in number and kind by hereditary, stirp or germinal influences, and thus result in the independent evolution of similar types in widely-separated regions under the *law of parallelism or homoplasy.*

This law causes the independent origin not only of similar genera but of similar families and even of our similar orders. Nature thus repeats herself upon a vast scale, but the similarity is never complete and exact. When migrations are favored by over-population or geographical changes, a new and severe test of fitness arises by the mingling and competition of the parallel types.

Now under the operation of these laws a most interesting generalization or hypothesis can be made as to the three realms, geographical isolation has been so continuous and prolonged that great orders of mammals have been evolved (Chart IV.) in each. Thus *Arctogæa* containing the broadest and most highly diversified land area, appears hypothetically as the center in which fourteen primitive and specialized orders radiated from each other. In the southern portion of *Neogæa,* at least four orders sprang from primitive members of the above orders, and the Hystricomorph rodents enjoyed their chief radiation. In *Notogæa* two orders were cut off by the sea, one of them a rapidly declining type, the Monotremes, the other the Marsupials enjoying a very highly diversified radiation. This hypothesis is expressed in Chart IV. Two other orders of mammals, the Sirenia (probably a branch of the hoofed tribe), took the rivers and coasts of America, Europe and probably Africa as their radiating center, while the Cetacea occupied the fourth or oceanic realm.

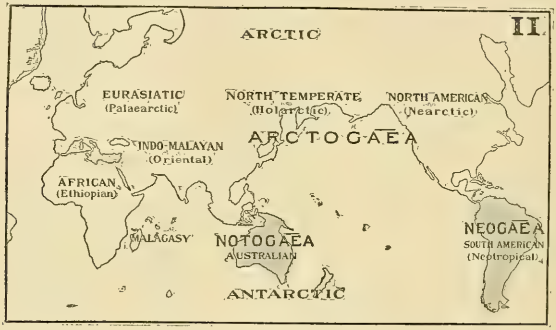

CHART II.—Division of the World into three Realms and nine main Geographical Regions. The continental platform is raised to the 200 metre line showing the main Tertiary land connections.

Now, we mean to express by this hypothesis that *Realms* were the main centers of *adaptive radiation of orders,* by no means the exclusive areas of distribution, for during the periods of land contact certain members of these orders found their way into adjacent realms. Each realm, therefore, contains its pure autocthonous types and its migrant or derived types. *Regions,* on the other hand, may be distinguished from realms as geographical and zoological areas, which have been isolated from each other for shorter periods, either by climatic barriers, as in the case of the Arctic or circumpolar region, or by great physical barriers, such as masses of water and of desert sands. In certain cases these regions, such as Africa, appear to have been so large, distinct and isolated as to have become important centers of the radiation of certain *orders* of mammals, and almost attain the rank of realms, but regions in general are chiefly and permanently distinguished by the *adaptive radiation of families of mammals.*

Arctogæa may thus be still divided on the old lines into five or six regions, the *Arctic* or Circumpolar; the *Ethiopian* or African, south of the Sahara; the *Indo-Malayan* or Oriental, including southern Asia and the Malayan islands; the *Malagasy*, including Madagascar; the *Nearctic* and the *Palaearctic*. There is no question, as suggested by Professor Newton in his term 'Holarctic,' and by Professor Allen in 1892, in his term 'North temperate,' that the North American (Nearctic) and Eurasiatic (Palaearctic) regions are now so closely similar that they might be united into one. When, however, the zoological or existing characteristics of these regions are put to a paleontological test it is found necessary to separate them, because throughout the Tertiary period North America and Eurasia were so remote that, to a certain extent, they constituted centers, not only of independent family, but to a limited degree of ordinal radiation. At the same time they were unified, both by frequent intermigrations and by a simultaneous evolution of allied animals.

We now come to one of the greatest triumphs of recent biological investigation, namely, the concurrence of botanical, zoological and paleontological testimony in the reconstruction of a great southern continent to which the name Antarctica has been given. Following Blanford (1890), in 1893 Forbes* made the first strong plea for this continent. The flood of evidence for the Antarctica theory has now become so strong that only a few details can be mentioned: Forbes (1893) and Milne-Edwards from the consideration of the birds; Beddard (1895) from the study of worms and other invertebrates; Moore (1899) from the study of the flora of South Africa; Spencer (1896) from the study of the fauna of Australia; Ameghino, Hatcher, and Ortmann from studies and collections of vertebrate and invertebrate fossils in Patagonia not yet fully published; Moreno (1899) from the discovery of Miolania, an Australian fossil reptile recently found in South America. From these and many other sources has been brought forth the body of testimony which draws us almost irresistibly* to the conclusion that there was an Antarctic continent at various times connecting South America, South Africa, Australia and New Zealand. Such a connection strengthens Huxley's conception announced in 1868, that the zoological regions were mainly upon lines of latitude, rather than as suggested by the present configuration of the earth, upon lines of longitude. With the theoretical elevation of this submerged continent (Chart III.) which may be called the 'Antarctic Region,' so as to connect the southern land masses at various times, all present and past geographical distribution may be theoretically accounted for. Elevation to the 10,000 foot (3040 meter) line still leaves a broad channel south of Africa. Without such elevation we are still met by many insuperable difficulties.

Among other problems, a land connection between Africa and South America across the South Atlantic enables us to explain the remarkable distribution of the sirenia, sea-cows, dugongs and manatees, now found exclusively in the tropical belt of Africa and the Americas. (See Sirenia, Chart

*H. O. Forbes, *Geographical Journal*, 1893. Also *Natural Science*, 1893, p. 54.

*After discussing the evidence with great fairness Lydekker (1896) takes a more conservative position.

IV.) These animals first appear in the oligocene of Germany. It is also, of course, possible that they may have taken a northern route as indicated by the remains of *Rhytina* in the North Pacific.

Dr. Louis Dollo, of Brussels, has recently endeavored to demonstrate that all *Marsupials* have been evolved from arboreal forms like the Opossum.* If we can draw a parallel with the adaptive radiation of the

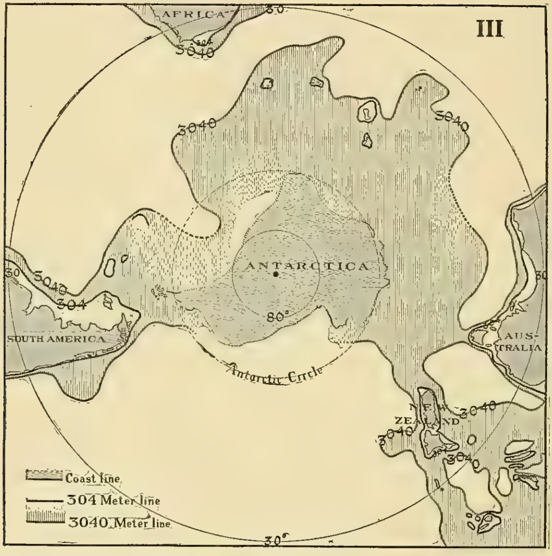

CHART III.—Restoration of Antarctica by elevation to the 3040 sounding line, showing old continental lines and greater depth between Africa and Antarctica.

Before confining our attention to *Arctogæa*, let us further consider the mesozoic relations of the three realms. (Chart I. and Chart II.)

In the Jurassic period stem forms of Insectivores, Marsupials and possibly of Monotremes* are found in Arctogæa and seem to establish the theory of northward origin of the mammalia as a class.

placentals during the 3,000,000 years, more or less, of the Tertiary, we may safely conclude that such a primitive family, entering the Australian region during the Cretaceous period either by way of Antarctica (Spencer) or by way of the Oriental region (Wallace and Lydekker), might have peopled Australia with all its wonderfully diversified forms of Marsupial life. The Didelphyidæ are to the Marsupials what the Creodonts are to the placentals in point of potential

* The writer's view (1888) that the Jurassic Mammals of England and Wyoming embrace primitive placentals or Insectivores as well as Marsupials and Multituberculates (? Monotremes) is now generally accepted.

* Les Ancêtres des Marsupiaux étaient-ils arboricoles? Miscellanées Biologiques, Paris, 1899.

evolution. The *Monotremes* also may have entered Notogæa by either of these routes.

North America is the only part of the globe where Cretaceous mammals are known at present. In the late Cretaceous we appear to discover evidence of the existence of the following orders: Insectivora, Creodonta or ancestral Carnivores, hoofed animals or Amblypoda and perhaps the earliest Monkeys or Mesodonta. In the basal Eocene we certainly find primitive Monkeys or Mesodonta; Rodentia and Tæniodonta or ancestral Edentata. A land connection with South America in the early Eocene would therefore have supplied *Neogæa* with the Edentates as well as the stem forms from which might have been derived its wonderful radiation of hoofed animals—the Litopterna, Typotheria and Toxodontia; together with the remarkable radiation of the Hystricomorph or porcupine-like rodents and of two families of Monkeys.

The exact zoological affinities of the oldest mammalian or *Pyrotherium* fauna of South America remain to be determined. *Pyrotherium* itself is considered by Ameghino (1895) as the source of the order Proboscidia while other ungulates are believed to be related to the Hyracoidea, upon the affinities of these forms turns the problem whether South America derived the sources of its great radiation from Africa or from South America. (See Chart IV.)

Chart IV.—Order of Mammals placed in their hypothetical chief centers of adaptive radiation during the Tertiary Period.

Four streams of migration to and from Neogæa appear to have occurred; the first established its autochthonous fauna or distinctive radiation of peculiar ungulates and edentates. The second related this region with Africa, via Antarctica; this contact, in addition to the problematical Proboscidia and Hyracoidea above alluded to, apparently introduced stem forms of Edentates into the Ethiopian region from which were derived the Pangolins and Aard Varks; these peculiar edentates together with Armadillos all occur in southern France in the lower Oligocene (Fihol, 1893); this land bridge also distributed the Cape Golden moles, *Chrysochloridæ;* these facts and others too numerous to mention serve to show the vast importance of the explorations in Patagonia and make us impatient for the exact conclusions which are forthcoming from the materials brought together by Ameghino and Hatcher.

The third migration into Neogæa established its links with Australia, bringing in Marsupials, both polyprotodont and diprotodonts. The fourth was from the north, Arctogæa, and is positively known ; it occurred at the end of the Miocene, and brought in the northern Carnivora, Bears, Wolves, Cats, and Sabre-tooth Tigers, Raccoons and Mustelines, the Artiodactyla, deer and camels, the Perissodactyla, horses and tapirs, three types of Rodents, the Squirrels, Mice and Hares or Rabbits and the Mastodon. The Notogæic types, as well as the animals of the first invasion, in the meantime had largely died out, and the introduction of more vigorous Arctogæic types, especially the carnivores, together with a change of climate, exterminated a further portion of the autochthonous Neogæic fauna. At the same time, that is of this second invasion, many of the South American forms entered North America; they seem to have reached this continent in the upper Pliocene.

We now turn to Arctogæa. In the Eocene period we find in Europe and North America what may be considered the pure or Autochthonous fauna of the Holarctic region, in the absence of all knowledge of Asia. Southern Asia is an absolute *terra incognita* the earliest known deposits in this region being in the Upper Oligocene in which the fauna is remarkably similar to that of Europe. Northern Asia is unknown paleontologically until the Pleistocene—here is a region for explorers. However, we may consider it as part of a broad Eurasiatic land area—extending from the Rocky Mountain Region to Great Britain. The faunal relations are astonishingly close, between the new and old worlds at this time. Every year's discovery increases the resemblance and diminishes the differences between Europe and the Rocky Mountain region. Distinguishing North America, however, are the Tylopoda, this sub-order includes the peculiar Artiodactyla of the Camel-llama tribe ; these Professor Scott in a recent paper considers as including all the early types of American ruminants which we have been vainly endeavoring to compare with European types. The radiation of the Tylopod phylum into a great variety of types is quite conceivable and it is thoroughly consistent with the fundamental law of adaptive radiation which we find operating over and over again.

In Europe there are in the upper Eocene two classes of animals, first those which have their ancestors in the older rocks. The second class includes certain highly specialized animals which have no ancestors in the older rocks—among these, perhaps, are the peculiar flying rodents or *Anomaluridæ*, now confined to Africa, and secondly the highly specialized even-toed ruminant types—the Anoplotheres, Xiphodonts and others, the discovery of which in the *Gypse* near Paris—Cuvier has made famous. It is tempting to imagine that these animals did not evolve in Europe but that they represent what may be called the first invasion of Europe by African types from the Ethiopian region.

It is a curious fact that the African continent as a great theater of adaptive radiation of Mammalia has not been sufficiently considered. It is true that it is the dark continent of paleontology for it has practically no fossil mammal history but it by no means follows that the Mammalia did not enjoy an extensive evolution there.

Although it is quite probable that this idea has been advanced before—most writers speak mainly or exclusively of *the invasion of Africa by European types.* Blanford and Allen it is true have especially dwelt upon the likeness of the Oriental and Ethiopian fauna but not in connection with its antecedent cause. This cause I believe to have been mainly an invasion from south to north correlated with the northern extension of Ethiopian climate and flora during the Middle Tertiary. It is in a less measure due to a migration from north to south. Let us therefore clearly set forth the hypothesis of *the Ethiopian region, or South Africa, as a great center of independent evolution* and as the source of successive northward migrations of animals, some of which ultimately reached even the extremity of South America—I refer to the Mastodons. This hypothesis is clearly implied if not stated by Blanford in 1876 in his paper upon the African element in the fauna of India.

The first of these migrations we may suppose brought in certain highly specialized ruminants of the upper Eocene, the Anomalures or peculiar flying rodents of Africa; with this invasion may have come the Pangolins and Aard varks, and possibly certain Armadillos, *Dasypodidæ*, if M. Filhol's identification of *Necrodasypus* is correct. A second invasion of great distinctness may be that which marks the beginning of the Miocene when the Mastodons and Dinotheres first appear in Europe, also the earliest of the Antelopes. A third invasion may be represented in the base of the Pliocene by the increasing number of Antelopes, the great giraffes of the Ægean plateau, and in the upper Pliocene by the Hippopotami. With these forms came the rhinoceroses with no incisor or cutting teeth, similar to the smaller African Rhinoceros, *R. bicormis*. Another recently discovered African immigrant upon the Island of Samos in the Ægean plateau is *Pliohyrax* or *Leptodon*, a very large member of the Hyracoidea, probably aquatic in its habits, indicating that this order (popularly known as the conies) enjoyed an extensive adaptive radiation in Tertiary times.

It thus appears that the Proboscidia, Hyracoidea, certain edentata, the Antelopes, the Giraffes, the Hippopotami, the most specialized ruminants and among the rodents, the Anomalures, the Dormice, the Jerboas and among Monkeys the Baboons may have enjoyed their original adaptive radiation in Africa—that they survived after the glacial period, only in the Oriental or Indo-Malayan region, and that this accounts for the marked community of fauna between this region and the Ethiopian as observed by Blanford and Allen.

Against the prevalent theory of Oriental origin of these animals is: first, the fact observed by Blanford and Lydekker in the Bugti Beds (Sind) that the Oligocene or lower Miocene fauna of the Orient is markedly European in type; second, that if these animals had originated in Asia some of them would have found their way to North America; third, the fact that all these animals appear suddenly and without any known ancestors in older geological formations. These are the main facts in favor of the Ethiopian migration hypothesis.

In the meantime the unification of the North American and Eurasiatic regions was proceeding by intermigration. In the lower Oligocene the giant pigs or elotheres, the Tapirs and peculiar amphibious rhinoceroses, known as Amynodons, found their way from America to Europe, while Europe supplied us with a few Anthracotheres, both Anthracotherium and Hyopotamus. In the Miocene Europe sent us the true Cats and we supplied Europe with the destructive sabre tooth tigers; in the upper Miocene Europe sent us our first deer and cattle or *Cervidæ* and *Bovidæ*, also probably the Mastodons *en route* from Africa. In the Pliocene we supplied Europe with the rabbits and hares, and possibly with the raccoons, if the Panda belongs to this family. In the Pleistocene the Camels wandered into Asia from America, while the Bears passed them *en route* to America. These are a few instances out of many which are already well known.

On the other hand certain families had an exclusively Eurasiatic history, so far as we know. These are, among animals related to the horse and tapir, the Palæotheres and Lophiodon ; among ruminants the Traguline deer and Muntjacs ; among insectivores the hedgehogs; among primates, the Anthropoid Apes and the lemurs. The latter are peculiar to the Malagasy and Ethiopian regions. At the same time America exclusively raised the Titanotheres,* the *Hyracodontidæ* or cursorial rhinoceroses, the pouched rodents or *Geomyidæ*, all the early families of Tylopoda, the peccaries. It is paradoxical that so many animals which we are wont to consider typically American came from the Eurasiatic region, while so many others which we always associate with Asia and Africa came from this country. Herein lies the necessity of a paleontological basis for zoogeography.

PLEISTOCENE DIVISIONS IN EUROPE.

The Pleistocene Quaternary or Glacial Age is the period in which the present distribution of animals and plants was determined. In this period the fulness of European investigation is in strongest contrast with the indecisive results of American work and in no other period can we anticipate more weighty inductions from Holarctic correlation. It is especially important to determine the relative antiquity of the first recorded traces of man in the two continents.

It is true the Pleistocene history of Europe is still in a formative stage, but it is absolutely evident that a final and positive time scale and subdivision of the early Age of Man is not far distant and that the vast labors of geologists, botanists, zoologists, paleontologists and anthropologists will be rewarded with a harmonious theory of all its phenomena.

Combined attack by geological and biological methods has nowhere produced more brilliant results. The unaided testimony of the rocks and soils fails to tell us of the successive advances and retreats of the ice but where, owing to the obliteration of surface deposits, geology is in confusion, plant and animal life serves both biology and meteorology like a vast thermometer actually recording within a few degrees the repeated rise and fall of temperature. This record consists of the invading and retreating life waves of river, forest, field, barren ground, steppe, tundra and arctic types, with increasing cold, or the reversed order, with diminishing cold, in the same localities or geographical areas. There seems to be sufficient evidence for a main division of the Pleistocene as follows :

Upper Pleistocene =	*Postglacial.*	
Middle Pleistocene	Upper	*Glacial.*
	Middle	
	Lower	
Lower Pleistocene =	*Preglacial.*	

Briefly the prevailing views in Europe as to the glacial age are told in Chart V.

(1) The preglacial stage presents a mingling of south temperate, temperate and northern forms of mammals.

(2) The long first glacial advance was followed (Pohlig) by the Rixdorf stage, intermorainal, colder than the succeeding Mosbach and Thuringian stages which have a more temperate facies in the recurrence of some of the Forest Bed Fauna.

(3) The faunal evidence for a colder mid-glacial period is conclusive. The evidence for a second or mid-glacial advance, between the first and last great glacial stages, is mainly biological, that is, subarctic are followed by more temperate life forms, as we gather largely from studies of the rodent fauna by Nehring, Studer and others. The hypothesis of three distinct glacial advances and of two inter-glacial retreats rests therefore upon a combination of geological and biological evidence which is not as yet conclusive.

* A Titanothere is reported in Roumania.

(4) There followed the postglacial, neolithic, alluvial stage.

Geographically the beginning of the Pleistocene is remarkable for its *broad land connections* and it represents the last stage of that community of fauna which during the Pliocene distinguished the entire region of Europe, Asia, Africa and North America. These connections may all be restored by raising the continents to the 200-meter or 100-fathom line as shown in Chart II. The mid-Pleistocene period in Europe is mainly one of *continental depression*; (1) at the climax of the first glacial advance extensive portions of northern Europe were submerged beneath the sea, (2) at the close of the first interglacial or temperate period (*Elephas antiquus* stage, Pohlig) occurred

CHART V.

PARTLY THEORETICAL DIVISIONS OF EUROPEAN PLEISTOCENE, AFTER POHLIG, DEPÉRET, NEHRING AND OTHERS.

I. Main Stages.	II. Partly Theoretical Relations of Glacial Oscillations.	III. Characteristic Geological Deposits.	IV. Faunal Div. (Pohlig.) Localities. Climate. Gen. Fauna. Stratigraphical Faunal and Geological Succession.	V. Human Remains and Characteristic Mammals.
Neolithic implements. UPPER PLEISTOCENE. Post-Glacial or Alluvial.	Recession of Glaciers.	Humus, Lake Terraces. Post-Glac. Löss.	**Prehistoric Stage.** N. temperate. Forest, Upland, River and Field Fauna.	**Forest and Lake Dwellers.** Recently exterminated types.
(Moustiéren Human type.) Palæolithic implements.	3d Glacial. 2d Interglacial. 2d Glacial.	Löss, Valley Gravels, Cave Clays, Diluvium, Sands.	**Elephas primigenius stage.** N. Temperate and Boreal, Steppe and Forest Fauna. Up. Rodent, Steppe Fauna, Yellow Culture Layer; Lower Rodent Tundre Fauna. Subarctic Tundre Fauna. RHINOCEROS MERCKII.	**Neanderthal and Spy, human types. Steppe and Cave Dwellers.** Felis, Hyæna, Ursus spelæus, Cyon alpinus, Capra ibex, Ovibos, Rangifer, Bison priscus, Equus, R. tichorhinus, Elasmotherium, Elephas primigenius.
MIDDLE PLEISTOCENE. Glacial or Diluvial. (Chelléan Human type.)	Interglacial. 1st Interglacial.		**Elephas antiquus stage.** N. Temperate Thuringian tufa, Taubach (Weimar)	**Oldest human remains known, Molar teeth** (Nehring). Saiga prisca, Alces machlis, Capreolus, Lemmus, Alactaga saliens, Lepus, Elephas antiquus, E. primigenius, Rhinoceros merckii.
		Fluviatile, River Sands, and Gravels.	**Elephas trogontherii** Temperate. B. Mosbach Sands (Lower Terraces).	Felis spelæa, F. lynx. Bison, Sus scrofa, Cervus elaphus, Equus caballus, Rangifer, Hippopotamus, Arctomys.
		Gravels, Conglomerates, Sands.	A. Rixdorf Beds, Subarctic.	Megaceros, Ovibos, R. tichorhinus, R. merckii, Elephas trogontherii.
	1st Glacial.	Boulders. Erratics, Clays, Drift, Sea-terraces, Moraines.	Arctic.	Fauna unknown.
LOWER PLEISTOCENE. Preglacial or Transitional to Pliocene.	Advance of Glaciers.	Estuarine and Fluviatile, Marls and Sands.	**Elephas meridionalis stage.** Forest Beds (Norfolk). St. Prest. Durfort. Malbattu (Auvergne Puy de Dome). Chalon - St. Cosme (Bresse).	**Earliest palæoliths.** Machærodus, Hyæna spelæa, Ursus spelæus, Lutra, Ovibos, Hippopotamus, Bos primigenius, Equus stenonis, Rhinoceros etruscus, Elephas meridionalis, E. antiquus, Trogontherium.

the volcanic disturbances in Central Europe and the hot spring formation of Thuringia (Taubach, Weimar); at this time *all the old continental connections characteristic of the Tertiary and serving as land bridges for free Holarctic Oriental and Ethiopian migration began to break up in the following manner.* During the early mid-Pleistocene or *Elephas antiquus* stage (Pohlig) the English channel broke through the long pre-existing land-bridge between England and France; Great Britain was faunally isolated; similarly the Irish Channel was depressed and Ireland (Scharff, 1894) lost its land connection with Wales in the early Pleistocene and with Scotland in the newer Pleistocene. In the Mediterranean region, also, at the close of the first interglacial period (Pohlig), the land-bridge across Gibraltar, also that between Italy, Sicily and Africa was broken; Malta was isolated as an island and the great *Elephas antiquus* dwindled into the small insular type *E. melitensis.* To the eastward the Mediterranean Sea extended over the Ægean plateau, which had previously been terra firma, and the new Ægean Sea cut off the land connection between Greece and Asia Minor.

I. *Preglacial. Elephas meridionalis Period.*

The typical preglacial deposits are the *Forest Beds* of Norfolk, England. The weight of opinion and of fact is all upon the side of considering these beds as Pleistocene. From the lists given by Dawkins, Schlosser and other writers, the Preglacial period is found to contain:

12 Pliocene species.

32 Pleistocene species and races, now extinct.

17 Living species, of which 7 are Insectivora and Cheiroptera.

The most remarkable feature of this fauna is the mixture of African and North Asiatic forms. The great *Elephas meridionalis* a precursor of the Mammoth, is the most characteristic type. The first traces of man in the paleolithic flints of the Chéleen type occur upon this level.

The climate, judging by the flora and Conchylien fauna, was somewhat cooler than that of the upper Pliocene. The first arctic flora in England is in a layer which separates the *Forest Bed* from the glacial Boulder Clays. To this period, according to most authorities, the *Pithecanthropos erectus* of Dubois belongs. Others, including the late Professor Marsh, consider this link between man and apes, of Pliocene age.

II. *Glacial and Interglacial, or Mid-Pleistocene.*

1. *Lower Mid-Pleistocene. Lower Stage.*—In climate the early part of this period, immediately during and succeeding the ice period, was very extreme. None of the first ice period fauna is known unless we except *Elephas (primigenius) trogontherii* or *E. intermedius* and the red deer, *Cervuselephas,* the latter being doubtfully recorded from the Boulder Clay of England. Here, in the Rixdorf beds, we find the first arctic and subarctic types of animals in central Europe.

Middle Stage.—This stage (Mosbach Sands, Essex) marks the recurrence of a *more temperate climate,* first observed by Lyell and Evans in England and abundantly known in Germany and France. Two only of the characteristic Pliocene species recur, the hippopotamus and straight-tusked elephant. These alone have been universally cited as evidence of a south temperate or even of a tropical climate, but the more numerous hardy types which are found in this stage constitute still stronger proofs of a north temperate climate.

Geologically the deposits are of fluviatile origin consisting of river sands and gravels containing *Hippopotamus, Rhinoceros merckii* and Mammoth. The great beaver, *Trogontherium cuvieri* makes its last appearance here. *Geographically* the southern continental depression has not begun and the Lower Pleistocene land bridges persisted.

The Mosbach and Essex fauna give the following percentages:

4 Pliocene species (including two living types).
7 Pleistocene species, now extinct.
16 Living species (including 2 Pliocene species).

The characteristic Pleistocene types which are first recorded in Mosbach are early varieties of the Irish, Red and Roe deer, the moose and the cave lion, *Felis spelæa.* Among the living species recorded for the first time or making their first appearance at this stage are the Reindeer, Boar, Horse, Lynx, Badger and Marmot.

Upper Stage.—According to Pohlig, the mid-Pleistocene proper, or succeeding stage, was characterized by volcanic disturbances in central Europe and by the deposition of gypsum and tufas. Probably these earth movements were connected with the marked geographical changes brought about by wide-spread depression of the continental borders and isolation, which the same author assigns to this period. The fauna, typically represented in the Thuringian tufas, indicates a cooler or north temperate climate. *Elephas antiquus* is very abundant, making its last appearance north of Italy. The typical locality is the Thuringian tufa in which Pohlig records 61 species. Parallel with this is the Taubach, near Weimar fauna.

In 1895 Nehring reported from this level what he regarded as the *oldest human remains* thus far found in Europe, consisting of two very large molar teeth resembling in some respects those of the Chimpanzee; this man he considered of the Chéleen type. In the same year Newton described a human skeleton of Esquimaux type in the still older 'Higher Terraces' or Hippopotamus level of Kent, England. The antiquity of this skeleton is, however, rendered somewhat doubtful by the fact that the skull is of much newer type than those of Neanderthal and of Spy, and the evidence for its extreme paleolithic age is not considered absolutely conclusive.

The faunal list is provisionally analyzed as follow:

3 Pliocene species still living (Castor, Hyæna, Arvicola).
7 Pleistocene species, now extinct.
23 Living species (including living Pleistocene Northern types).

The number of recorded living species increases, there being a marked increase especially in the number of Reindeer. The most important new living types are: the steppe antelope, *Saiga prisca* (*tartarica*), the moose, *Alces machlis*, the lemming, *Myodes lemmus*, the Siberian jerboa, *Alactaga saliens*, the porcupine, *Hystrix*, the rabbit, *Lepus timidus.* These constitute a distinct invasion of north Asiatic forms to the southern steppes.

2. *Upper Mid-Pleistocene or Elephas primigenius Stage Pohlig.*—As we enter the next succeeding Loess and Cave Period of Central Europe, the main life stage of the mammoth, *Elephas primigenius*, the wooly rhinoceros, *Rhinoceros antiquitatis* or *tichorhinus*, and the reindeer *Rangifer tarandus*, we note the decline of the broad-nosed rhinoceros *Rhinoceros merckii* and the absence of the straight-tusked elephant *Elephas antiquus* in geological deposits which are chiefly diluvial gravels, and sand clays. These facts alone indicate a prolonged colder period, a north temperate or boreal climate. The fauna presents a great variety adapted to different degrees of temperature but decidedly of northern type. Other facts indicate that this colder period was initiated by a distinct advance of the ice followed by a gradual recession, namely, the occurrence of arctic and sub-arctic types succeeded by north temperate types, in a number of localities, typically near Schaffhausen. (Nehring, Steinmann, Schlosser.)

These successive northern faunas in single localities are typically as follows: 1. Tundre Fauna; 2. Steppe Fauna; 3. Forest Fauna.

Europe now included a most remarkable diversity of life of Asiatic, North Siberian, Oriental and African origin. The climate was cold and relatively dry. The Reindeer, first the barren ground then the woodland variety, increased rapidly in number during this period and constituted its most distinctive form, hence this is known as the Reindeer period.

This stage is famous for the skeletons of man, the man of Néanderthal and Spy, very primitive in the structure of the skull, the oldest human skeletal remains with the exception of the *Pithecanthropus* of Java.

III. *Upper Pleistocene. Postglacial.*

As above observed there is a difference of opinion as to the interglacial or postglacial age of the loess. All the North Siberian, Oriental and African types gradually disappear, the modern European forest and field fauna alone survives. There is some evidence that both the Mammoth and Reindeer lived for a time in this period, the latter being now confined to more northern Europe. The Irish deer, *Megaceros hiberniæ* the Reindeer, the bovidæ *Bos taurus*, *Bos longifrons*, and *Bos brachyceros*, are the characteristic ruminants. *Alces palmatus* is a postglacial Russian moose. The horse, *E. caballus*, of larger and smaller varieties was now domesticated and used for food. The carnivora, rodentia and insectivora were all of modern type.

The detailed comparison of the Pleistocene of Europe, America and Asia is still under way, and very important results may be expected from it. It will be equally serviceable to American anthropologists and paleontologists, for our own Pleistocene is far from being understood. The stages represented by our horse or *Equus Beds*, which are usually considered Lower Pleistocene, as well as of the Megalonyx and Cave Fauna of the East remain to be exactly fixed. Interest in this problem is greatly enhanced by the fact that we may at any moment discover the remains of man or of his ancestors associated with *Equus excelsus* and positively demonstrate the existence of man upon this continent at a period contemporaneous with his first appearance in Europe.

Henry Fairfield Osborn.

CRUISE OF THE ALBATROSS.
IV.

Mr. Agassiz's final letter to the U. S. Fish Commission on the voyage of the *Albatross* is dated Yokohama, Japan, March 5, 1900.

After coaling and refitting we left Suva on the 19th of December, and arrived at Funafuti on the 23d, stopping on the way at Nurakita, the southernmost of the Ellice Islands. I was, of course, greatly interested in my visit of Funafuti, where a boring had been made under the direction of a committee of the Royal Society, in charge of Professor David, of Sydney, after the first attempt under Professor Sollas had failed. The second boring reached a depth of more than 1100 feet. This is not the place to discuss the bearing of the work done at Funafuti, as beyond the fact of the depth reached we have as yet no final statement by the committee of the interpretation put upon the detailed examination of the core obtained, and now in the hands of Professor Judd and his assistants. In addition to the above-named islands, we also examined Nukufetau, another of the Ellice group.

After leaving Nukufetau we encountered nothing but bad weather, which put a stop to all our work until we arrived under the lee of Arorai, the southernmost of the Gilbert Islands. On our way to Tapateuea from there we steamed to Apamama and Maiana, which we examined, as well as Tarawa. We next examined Maraki, an atoll which is nearly closed with high beaches, having only two small boat passages leading through the narrow outer land-rims. Both Maraki and Taritari, the the last island of the Gilberts which we examined, are remarkable for the development of an inner row of islands and sandbars in certain parts of the lagoon parallel to the outer land-rim, a feature which also exists in many of the Marshall Islands atolls.

We reached Jaluit the 9th of January, and after a few days spent in coaling, we spent about three weeks in exploring the Marshall Islands, taking in turn the atolls of the Ralick Chain to the north of Jaluit: Ailinglab Lab, Namu, Kwajalong, and Rongelab; and then the atolls of the Ratack Chain, Likieb, Wotje, and Arhno. The atolls of the Marshall Group are noted for their great size and the comparatively small area of the outer land-rims, the land-rims of some of the atolls being reduced to a few insignificant islands and islets. In none of the atolls of the Ellice, Gilbert or Marshall Islands were we able to observe the character of the underlying base which forms the foundations of the land areas of these groups. In this respect these groups are of striking contrast to the Paumotus, the Society Islands, the Cook Group, Niue, the Tongas, and the Fiji Islands where the character of the underlying foundations of the land-rims is readily ascertained. But, on the other hand, these groups give us the means of studying the mode of formation of the land-rims in a most satisfactory manner, and nowhere have we been able to study as clearly the results of the various agencies at work in shaping the endless variations produced in the islands and islets of the different atolls by the incessant handling and rehandling of the material in place, or of the fresh material added from the disintegration of the sea or lagoon faces of the outer land, or of the corals on the outer and inner slopes. It has been very interesting to trace the ever-varying conditions which have resulted in producing so many variations in the appearance and structure of the islands and islets of the land-rims of the different groups.

The boring at Funafuti will show us the character and age of the rocks underlying the mass of recent material of which the land-rim, not only of that atoll, but probably also that of the other atolls of the group and of neighboring groups, is composed, though of course we can only judge by analogy of the probability of the character of the underlying base from that of the nearest islands of which it has been ascertained. When we come to a group like the Marshalls we have as our guide only the character of the base rock of the islands of the Carolines, which is volcanic, while Nauru and Ocean Islands, to the west of the Gilberts and to the southwest of the Marshalls, indicate a base of ancient tertiary limestone.

Owing to the continued stormy weather and the probability of not being able to land at these islands while the unfavorable conditions lasted, we did not attempt to visit them.

After leaving Suva we made a number of soundings from south of Nurakita toward the Marshall Group, which, in addition to those of the 'Penguin,' clearly show that the Ellice Islands are isolated peaks rising from considerable depths (from 1500 to over 2000 fathoms) and that the same is the case with the Gilbert Islands. We made about thirty soundings between the atolls of the Marshalls, which appear to show that they also rise as independent peaks or ridges, with steep slopes, from 2000 to 2500 fathoms, and that the so-called parallel chains of atolls of the Marshalls, the Ralick and Ratack, are really only the summits of isolated peaks rising but a few feet above the sea-level. The Marshall Islands, as well as the Ellice and

Gilbert, seem to be somewhat higher than the Paumotus, but this difference is only apparent and is due to the difference in the height of the tides, which is very small in the Paumotus, while in these groups it may be five and even six feet.

From Jaluit we visited among the Carolines, the islands and atolls of Kusaie, Pingelap, Ponapi, Andema, Losap, Namu, the Royalist Group, Truk and Namonuito, obtaining thus an excellent idea of the character of the high volcanic islands of the group from our examinations of Kusaie and of Ponapi, while the others represent the conditions of the low atolls, having probably a volcanic basis, but this was not observed at any of those we examined.

The reefs of the volcanic islands of the Carolines are similar in character to those of the Society Islands, though there are some features, such as the great width of the platforms of submarine erosion of Ponapi and of Kusaie, and the development of a border of mangrove islands at the base of the volcanic islands, which are not found in the Society Islands.

The Truk Archipelago was perhaps the most interesting of the island groups of the Carolines, and it is the only group of volcanic islands surrounded by an encircling reef which I have thus far seen in the Pacific which at first glance lends any support to the theory of the formation of such island-groups as Truk by subsidence. This group was not visited by either Darwin or Dana; and I can well imagine that an investigator seeing this group among the first coral reefs would readily describe the islands as the summits, nearly denuded, of a great island which had gradually sunk. But a closer examination will readily show, I think, that this group is not an exception to the general rule thus far obtaining in all the island groups of the Pacific I have visited during this trip; that we must look to submarine erosion and to a multitude of local mechanical causes for our explanation of the formation of atolls and of barrier and encircling reefs and that, on the contrary, subsidence has played no part in bringing about existing conditions of the atolls of the South and Central Pacific.

Nowhere have we seen better exemplified than at Truk how important a part is played by the existence of a submarine platform in the growth of coral reefs. The encircling reef protects the many islands of the group against a too rapid erosion, so that they are edged by narrow fringing reefs, and nowhere do we find the wide platforms so essential to the formation of barrier reefs. The effect of the northeast trades blowing so constantly in one direction for the greater part of the year is of course very great; the disintegration and erosion of islands within its influence is incessant, and their action undoubtedly one of the essential factors in shaping the atolls of the different groups, not only according to the local positions of the individual islands, but also according to the geographical position of the groups. Thus far I do not think any observer has given sufficient weight to the importance of the trades in modifying the islands within the limits of the trades, nor has anyone noticed that the coral reefs are all situated practically within the limits of the trades both north and south of the equator.

The soundings made going west from Jaluit to Namonuito indicate that there is no great plateau from which the Carolines rise, but that the various groups are, as is the case with the neighboring groups of the Marshalls and Gilberts, isolated peaks with steep slopes rising from a depth of over 2000 fathoms. The line we ran from the northern end of Namonuito to Guam developed the eastern extension of a deep trough running south of the Ladrones. The existence of this trough had been indicated by a sounding of 4475 fathoms to the southwest of Guam made by the *Challenger*. We obtained, about 100 miles southeast of Guam, a depth of 4813 fathoms, a depth surpassed only, if I am not in error, by three soundings made by the *Penguin* in the deep trough extending from Tonga to the Kermadecs.

I was very much surprised, in approaching Guam from the eastward, to find that the island was not wholly volcanic, but that the northern half has been built up of elevated coralliferous limestone. The vertical cliffs bordering the eastern face rise from a height of 100 to 250 or 300 feet at the northern extremity, and resemble in a way similar islands in the Paumotus (Makatea), Niue, Eua, Vavau and others in the Fijis which had made their cliffs a familiar feature in our explorations. In fact, outside of Viti Levu and Vanua Levu, this is the largest island known to me where we find a combination of volcanic rocks and of elevated coralliferous limestone. The massif forming the southern half of the island is volcanic, and the highest ridge, rising to about 1000 feet, runs parallel to the west coast, the longest slope being toward the east.

This volcanic mass has burst through the limestone near Agaña, and the outer western extension of the coralliferous limestone exists only in the shape of a few spurs running out from the volcanic mass, the largest of which are those forming the port of San Luis d'Apra. These spurs are separated by lower ridges of volcanic rocks extending to the sea from the main central mass. To the north of Agaña the limestone forms an immense irregular mesa, cut by deep crevasses, full of pot-holes and sinks, rising gradually westward to a height of 350 or 400 feet. Near the northern extremity of the island a volcanic mass, Mt. Santa Rosa, has burst through the limestone and rises about 150 feet above the general level of that part of the island. The shore stratification of the bluffs is much distorted in the vicinity of that volcanic outburst.

We left Guam in time to reach Rota by day, and found that this island is a mass of elevated coralliferous limestone, the highest cliffs of which reach a height of 800 feet. Perhaps in none of the elevated islands have we been able to observe the terraces of submarine elevation as well as at Rota, especially in the small knob at the southwest point of the peninsula separating Sosanlagh and Sosanjaya bays, which itself is also terraced ; no less than seven distinct terraces could be traced. There was no sign of any volcanic outburst except at the northwest point of the island, where both the character of the slope and of the vegetation would seem to indicate volcanic structure.

It is quite probable that others of the Ladrones, like Saipan, and the islands to the south, are composed in part at least of elevated limestone judging from the hydrographic charts and the sketches which accompany them. On many of the northern Ladrones there are active volcanoes, so that it is very possible that the volcanic outbursts which have pushed through the limestone, or have elevated parts of the islands of the group, are of comparatively recent date.

During the last part of our cruise, from Suva to Guam, the unfavorable weather greatly interfered with our deep-sea and pelagic work; in fact, with the exception of the soundings made to develop as far as practicable the depths in the regions of the various coral-reef groups we visited, we abandoned all idea of carrying out the deep-sea and pelagic work planned for the district between the Gilbert and Marshall and Caroline groups. To our great disappointment hardly any marine work could be accomplished, and our investigations were limited almost entirely to the study of the coral reefs of the regions passed through.

After Mr. Townsend's departure, Dr.

Moore continued to collect the birds of the islands where we anchored, and they have brought together a fairly typical collection of the avifauna of the South Sea Islands. Dr. Pryor collected the characteristic plants, and Dr. Mayer the insects and reptiles in addition to such pelagic work as could be done in port. Both Dr. Woodworth and Dr. Mayer took a large number of photographs, and we must have at least 900 views illustrating the coral reefs of the Pacific. Dr. Woodworth also collected incidentally such ethnological material as could readily be obtained during our short stay at different places.

We were everywhere received with the greatest cordiality and courtesy: by the Governor of the Paumotus, the King of Tonga, Sir George O'Brien (the High Commissioner of the Western Pacific at Suva), Mr. E. Brandeis (the Landes-Hauptman in charge of the Marshall Islands at Jaluit), and the Governor of the Carolines. The State Department at Washington having kindly asked through the French, English and German Embassies at Washington for the kind offices of the representatives of these nations in Oceania to the *Albatross* while in their respective precincts, thanks to these credentials nothing could exceed the interest shown everywhere in the success of our expedition.

I must also thank Capt. Moser and the officers of the *Albatross* for the untiring interest shown by them during the whole time of our expedition in the work of the ship, which was so foreign to the usual duties of a naval officer. A. Agassiz.

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*THE PRESENT STATE OF PROGRESS OF THE NEW REDUCTION OF PIAZZI'S STAR OBSERVATIONS.**

Between the years 1791 and 1814, Giuseppe Piazzi executed at Palermo, Sicily, the series of observations which enabled him to publish in 1814 his *Præcipuarum Stellarum Inerrantium Positiones Mediæ ineunte Sæculo XIX.* This was by far the most accurate and extensive catalogue of stars which had ever been published from original observations. But modern advances in this sphere of astronomical research have been fruitful in detecting many sources of error affecting the positions of stars as given in this catalogue. Methods for obviating these errors are known, however, provided there should be an entirely new reduction of all the observations—proceeding directly from each nightly record.

Several abortive attempts to supply this need of astronomy have been made during the last half-century. The impetus was given to the present undertaking by the writer in the summer of 1895, though the calculations were not actually begun until the fall of 1896.

Quotations from letters from such eminent astronomers as Professor Auwers, Dr. David Gill, Professor Schiaparelli, and others; and from the published works of Professor Simon Newcomb, Professor Lewis Boss, Dr. B. A. Gould and many others, show the imperative need of such a new reduction of Piazzi's observations.

In planning a work of this kind, after regard for general methods the first consideration becomes the quantity of work involved—as on that depends the financial outlay and the best disposition of energy. Some data on this point may be of interest.

The observations were made with two instruments: a transit instrument and a meridian circle. The catalogue records a few more than 147,600 observations with both telescopes. Of these Piazzi* himself estimated that 30,000 were made with the transit. The original observations are in

*Summary of a paper read before the Philosophical Society of Washington on March 31, 1900.

* Corrispondenza Astronomica fra Giuseppe Piazzi e Barnaba Oriani—letter of 26 May, 1815.

the *Storia Celeste** and it is safe to say that they will number 150,000. There are in the catalogue 7646 stars and in the *Storia Celeste* 216 more which had been discarded.

At the very beginning of the work the co-operation of Professor Porro of Turin was secured. Some years ago he had begun, while assistant to Professor Schiaparelli at Milan, an investigation of the independence of the observations on the transit instrument. By reason of his interest in that question and the work already done in connection therewith, he very readily consented to become responsible for the reduction of all the observations of the transit instrument while the writer assumed responsibility for all the observations on the Meridian Circle and the rest of the new reduction.

For the reduction of these latter 120,000 observations the work naturally is divided into parts depending on the process to be performed. The computation sheets for each process have been designated respectively as Form A, Form B, etc. The number of pages in each Form range from 386 to 8000 and are $8\frac{1}{2}$ by 11 inches in size. There are already printed and partly or wholly filled 22,500 such pages in the following Forms:

A. Journal of Notes, constants, methods, etc. ? %
B. Day-book and provisional reduction to 1800 10 %
C. Besselian Star-constants for 1800..........100 %
D. Tabulated values of the star-constants....100 %
E. Interpolated values of the day-numbers..100 %
F. Reduction from Apparent to Mean place ...40 %
H. Compilation of positions by other observers for deduction of proper motions ....10 %
M. Miscellaneous tables and short computations ? %

The percentage at the end of each line shows approximately the amount which is already accomplished. By very careful methods of checking endeavor is made to avoid numerical incorrectness, and though the work is being pushed with all energy possible, it is not being done in haste at the expense of accuracy.

It is a pleasure to record the zeal with which co-operation has been secured along several lines not strictly included in the direct operation of newly reducing Piazzi's observations, though vitally connected therewith. A re-observation of all Piazzi's stars for especial use in determining their proper motions has been undertaken (and is already far on its way towards completion) by Professor J. G. Porter of the Cincinnati Observatory and Professor R. H. Tucker of the Lick Observatory. Miss Flora E. Harpham and Professor Susan J. Cunningham are performing all the labor of compiling the star positions from other catalogues for deduction of proper motions. Others are doing other useful parts of the reductions and checkings.

So long ago as 1866, when writing the preface to his own reduction of D'Agelet's observations, Dr. B. A. Gould made the following statement:

"In addition to the motives already mentioned as having prompted me to undertake this reduction and catalogue, an especial incentive was found in the experience which it would afford and make available for a much more extended work which has long been a cherished project, a recomputation of Piazzi's observations and the formation from them of a new catalogue. This is an enterprise far too extensive for the powers of a private individual, but I look forward with much hopefulness to the possibility of obtaining the requisite means at some future time . . . No astronomical labor promises richer usefulness than this; and if the great work of reducing anew the observations of Bradley be carried out by a combination of the astronomers of Europe, as is now proposed, nothing seems more appropriate for the astronomers of the New World than to render a similar service by a new reduction of the *Storia Celeste*."

This statement is even more true now than when first written. Not alone have the observations of Bradley been newly reduced by Professor Arthur Auwers and published twelve years ago, but a new reduction of Mayer's catalogue was pub-

* Nine volumes published by Littrow at Vienna, 1845–49.

lished by the same eminent authority in 1894. A new reduction of Taylor's 11,015 stars is expected soon to appear from the Nautical Almanac Office of England. Thus the most important old catalogue which needs to be newly reduced is Piazzi's: and the object of my remarks has been to show that at the present moment a vast amount of the work incident thereto *is already accomplished.* Thanks to the generosity of Miss Catharine W. Bruce, of New York City, financial assistance was rendered for the employment of computers between June, 1898, and January, 1900, whereby much of this result was attained. But now the possibility of its completion rests not so much in the faithful persistence of those engaged in the computations as in the additional generosity of other patrons of astronomy, and in the continued encouragement which so many Observatories and individual astronomers have thus far seen fit to so kindly bestow.

HERMAN S. DAVIS.

WASHINGTON, D. C.

SCIENTIFIC BOOKS.

Scientific Papers. By JOHN WILLIAM STRUTT, Baron Rayleigh, D.Sc., F.R.S. Vol. I., 1869–1881. Cambridge at the University Press. 1899. Quarto, pp. i–xv., 1–562. New York, The Macmillan Co. Price $5.00.

In endeavoring to review this first volume (1869–1881) of the researches of an author like Lord Rayleigh, who has contributed fundamentally to whatever he has undertaken, and who speaks authoritatively on almost every topic in physics; in whose work, in other words, both the quality and the quantity are in evidence, it would be rash to attempt to give more than an outline of the contents. The papers moreover, are in general too severely difficult to be read as a whole, and there are no figures or diagrams (or almost none) to assist the imagination, no italics to stimulate curiosity. Many of the papers are theorems in pure mathematics, but in few cases (contributions to the mathematical tripos examinations, for instance) is the mathematical story left unadorned by the moral of an application. Lord Rayleigh is pre-eminently a physicist, and mathematics with him is good means to a better end.

The book opens (1869) with papers on the applications of dynamics to electro-magnetic phenomena, showing the influence of the inspiration of Maxwell and worked out along Maxwell's lines. Thus the analogy between the decomposition of water, produced or not produced according as the circuit of a Daniell's cell (alternately made through a shunt and broken through the electrolyte) contains a coil or not, and the action of an hydraulic ram, the analogy between the spark and the rupture of the pipe, etc., are all in the spirit of an accentuation of Maxwell's conception of electric inertia, long before Lodge had popularized that doctrine. The investigation leads to a consideration of circuits containing self induction and capacity, and is carried through two long papers largely experimental in character and similar to Henry's researches on the magnetization produced by oscillatory currents.

Then follow two papers on acoustics beginning a subject destined to culminate in 1877 in the well known work on sound, which like de St. Venant's elastics, has remained without a compeer. The shorter paper completes Sondhauss's theory on the influence of the size and the form of flasks on the sounds produced when a current of air is blown across their mouths, with the aid of Helmholtz's famous research on the vibration of open organ pipes. The longer is the great paper on the theory of resonance, published in three parts in the *Philosophical Transactions* of 1870. Rayleigh here also begins with Helmholtz's results for 'Hohlräume,' using a parallel but thoroughly different mathematical treatment. Part I. contains the general dynamics for resonators of small dimensions compared with wave length, and communicating with the air by any number of holes or necks, usually along an infinite plane, and a final application to the open organ pipe is sketched out. Part II. is devoted to the special problems relating to necks, etc., suggested in Part I. The neck is here considered relative to its 'resistance' to vibration, and the pertinent electrical analogy is used throughout the discussion. In part III. the theoretical deductions are verified by experiment for such cases as admit of accurate numerical computation. Much of this theory is embodied in the second volume of 'Sound' (16th Chapter).

After this Lord Rayleigh's mind seems to have been intensely attracted by optical phenomena, and we find first a critical examination of Verdet's diffraction theory of the solar corona, followed by a long experimental paper confirmatory of Maxwell's theory of color perception. The experiments aim at establishing the linear equation between any four colors with a higher degree of accuracy. They are made with Maxwell's educationally now very familiar color wheel. In 1871 came the two papers dealing with the dynamics of the blue sky, perhaps the most famous of Lord Rayleigh's theoretical researches. It is needless to refer to them at length here, since an easily intelligible presentation is given in Preston's theory of light (Art. 162). If the long waves are absorbed on transmission and the short waves scattered, the blue color of the sky is naturally a manifestation of the surviving mean wave lengths. Clausius, it appears, had previously developed an interferential theory to account for the same phenomenon at considerable length, but had subsequently rejected it chiefly because in the case of particles small in all their dimensions as compared with the wave length of light the ordinary laws of reflection no longer hold and an independent investigation is imperative. Without being aware of these misgivings, Rayleigh took up and completed the subject from the point where Clausius * left it. The former has frequently recurred to the same investigation, showing in a recent paper, for instance, that scattering may even be promoted by the molecules of air themselves.

* To me it seems probable that these researches of Clausius may be resuscitated in relation to the colors of cloudy condensation. As seen in the color tube by transmitted light, the yellows, oranges, browns, of the first order, ending eventually in opaque are undoubtedly Rayleigh's colors. The jet in reflected light is bluish. Beyond this, with increasing size of particles, the transmitted colors are violet, blue, green, yellowish, purple, etc., following Newton's color series, and to these, it would seem, that Clausius's investigations are applicable. I shall return to this interesting subject elsewhere.

Of the two optical papers which follow, the first, a theory of double refraction based on the hypothesis of difference of molecular inertia in different directions (given for instance by the case of a disc vibrating in a resisting fluid), seems to have been disproved shortly after in experiments of Stokes's. The other is an elaborate contribution to Fresnel's fundamental investigation on the intensity of light reflected from transparent media. Fresnel's expressions have been remarkably suggestive, and they are approximately true. The method by which the tangent formula is derived, however, is not rigorous, and he was of course unaware of Jamin's discovery of the change of phase which accompanies reflection. Green's, Cauchy's, MacCullagh's, Neumann's, and Lorentz's theories are successively examined, but the nature of the correction (Fresnel's result predicts extinction at the angle of polarization), or a derivation which shall satisfactorily dispose of the longitudinal wave is not ascertained. All this recalls Lord Kelvin's Baltimore lectures. A subsequent paper on the reflection of light from opaque matter is much along the same lines, being critical rather than constructive. It is curious that a man of Rayleigh's genius instead of wrestling with these abstruse elastic theories did not make an entirely new departure from the basis of the electromagnetic theory* of light, as did afterwards Helmholtz in his famous paper on dispersion.

At about this time the reproduction of diffraction gratings by photography, a fascinating subject engaged Lord Rayleigh's attention, and as in most of his work, grew eventually into an extended treatment of the degree of perfection attainable in gratings. Transparent gratings of Nobert, with 3000–6000 lines to the inch were found directly reproducible when used as negatives, and the copies proved nearly equal in quality to the original, showing for instance, the nickel line between the D's. Gelatine reproductions (obtained by the photolithographic process with chromate of potassium)

* Although Maxwell's electricity was not completed until 1873, one would suppose that the contents could not be quite unknown to Rayleigh.

surpassing the Nobert plate in brilliance also succeeded. Since to resolve the D lines the distance between the rulings must be true to 1/1000, this performance seems incredible. Yet Rayleigh anticipates no limit to his method up to 10,000 lines to the inch. Copies of similar gratings made in accordance with Rayleigh's directions are found in most of our laboratories. They have not held their own owing to the enormous stride forward in diffraction spectroscopy due to the invention of Rowland's concave grating. Connected with these papers is one on the diffraction of object glasses in telescopes, in which the advantage of a central stop to cut off superfluous light without destroying the definition is succinctly laid down.

Of Lord Rayleigh's highly important contributions to mathematical literature made at about this time, bare mention only is possible here. A paper on some general theorems relating to vibrations deals with great breadth of method with the reciprocal character of forces and motions of any two types. To quote an illustrative example: If A and B are two points of a stretched string, a periodic transverse force at A produces the same vibration at B as would have ensued at A for a force acting at B. Another paper treats of the numerical calculation of fluctuating functions (Bessel functions, for instance, though the method has broader scope) when the usual expansions in series fail. Again the reciprocal properties of systems capable of vibrating about a position of equilibrium, is accentuated in a further paper put in form of a statical theorem. Of these powerful theorems (together with a parallel theorem of Helmholtz) Rayleigh frequently makes effective use, and reference to them occurs in other parts of the volume, either in relation to sound or to light. Finally, the proof of Thomson's theorem, that if a material system start from rest under the action of given impulses, the energy of the actual motion exceeds that of any other which the system might have been guided to take under the operation of constraints, etc., is recast in such a way as to suggest important corollaries.

Two papers on thermodynamics now appear. It is Rayleigh's idea to utilize the fall of temperature between the furnace and the boiler as well as that between boiler and condenser by supplementing the steam engine with an auxiliary oil engine, and the development leads to a discussion of the doctrine of dissipation. Again the case where work may be gained by mixing gases, as for instance when hydrogen diffuses into air through a porous plug, is subjected to computation, by finding the work needed to separate a mixture. The line of reasoning adopted by Lord Rayleigh in this paper reminds one of the fundamental research of van't Hoff, though it breaks off with the isolated case under discussion. The interesting result is formulated that relatively more work is needed when the ingredient to be separated is present in small quantity.

At this point we come upon a series of distinctively hydrodynamic researches, beginning with a paper on gravitational waves. The case of the long wave in shallow water was solved by Lagrange, who showed that its velocity is identical with that of a heavy body falling half the depth of the canal. If the water itself moves with an opposed velocity, the wave form is of the steady type often observed in gutters conveying water. After enlarging the theory of long waves, Rayleigh applies it to find the effect on a stream of a contraction or a widening of the channel, to the case of the solitary wave (for which he finds a theoretical explanation agreeing with Scott Russel's observations. The solitary wave when positive, *i. e.*, an elevation, has considerable permanence. The negative wave on the contrary soon breaks up), to periodic water waves and to the oscillations of water in a cylindrical vessel.

This research is followed shortly after by an investigation of the resistance of fluids. Helmholtz had previously pointed out that finite slipping was left out of account on ordinary hydrodynamics. Rayleigh is induced to reopen the subject with the ulterior object of formulating the resistance encountered by a solid body floating in a stream. In the case of a plate it appears that the resistance to broadwise motion can be increased enormously by the superposition of an edgewise motion, a result of great value in aërial navigation. It recalls the striking results obtained by

Langley in the same direction. In a further paper the theory of the vena contracta and of colliding jets is subjected to analysis, in which (following Maxwell) the inferences are drawn directly from the principle of the conservation of linear momentum. To the question of jets, Rayleigh returns in succeeding papers. In the first of these the conditions of instability are discussed, both for capillary or statical instability, and for dynamic instability, such as occurs, for instance, in waves or surface of water under the influence of the wind. The other paper examines the capillary phenomena observed in jets issuing from an orifice which is not circular, but elliptic, triangular, etc. Apart from form, the wave lengths of the issuing stream have a close relation to the square root of pressure. Disposing of this case, Rayleigh then passes to the dismemberment of the circular jet into drops, or of an oblique jet into sheathes, using the experimental (shadow) method of Buff. A curious result of the analysis may be mentioned, viz, that the radius of the sphere which vibrates capillarly in seconds is about one inch. Rayleigh's more recent work with jets and ripples is not included in this volume, but interspersed among other hydrodynamic researches is the fascinating and well-known paper on the influence of electricity on colliding water drops, proving that whereas unelectrified drops rebound on collision, electrified drops coalesce. The conclusions are made more striking by the examination of paired jets, and an important inference is drawn relative to the growth of rain-drops stimulated by thunder storms. A further paper on the instability of fluid motions (the preceding cases being chiefly of interest in their relation to sensitive flames and smoke jets) reopens the whole question, obviating the preceding hypothesis of discontinuous fluid motion and admitting only such gradual changes of velocity as must inevitably occur in viscous liquids. A final paper is devoted to progressive waves, treating the case frequently observed that the group velocity of waves advancing into still water is often below the velocity of the constituent members of the group. The investigations are largely embodied in 'Sound.' They are referred to the case of two infinite wave trains of the same amplitude and nearly the same wave-length, superposed.

Meanwhile Lord Rayleigh has not lost interest in acoustical subjects. In a paper on our perception of the direction of a source of sound there occurs a humorous passage which is rare in his writings. "The efficient action of a lens" (for the purpose in question) "depends on its diameter being at least many times greater than the wave-length of light, and for the purposes of sight there is no difficulty in satisfying the requirement. The wave-length of the rays by which we see is not much more than a ten-thousandth part of the diameter of the pupil of the eye. * * * The waves of sound issuing from a man's mouth are about eight feet long, whereas the diameter of the passage of the ear is quite small, and could not well have been made a large multiple of eight feet." Usually the imputation of ears longer than 8 inches is regarded sufficiently undignified to be resented.

A similar paper with acoustical observations relating to binaural audition, reflection and interference of sound, pitch, etc., follows. Rayleigh then contributes to the few data then known of the amplitude* of the audible sound wave, by computing it roughly from the energy needed to blow a whistle and the distance of audibility, using a straightforward method which, like many others in the volume ought to find its way into our text-books. He finds the observed amplitude to have been of the order of $1/10^7$ centim., but believes the 1/40th part of it to be audible under favorable conditions. A paper on absolute pitch is concerned with the discrepancy observed between König's and Apunn's tonometers, which Rayleigh attributes to the mutual influence of simultaneously sounding reeds. He proposes a tuning fork clock method of his own. Another paper relating to Mayer's phenomenon of acoustic repulsion shows the pressure within a resonator to be in excess of atmospheric pressure, which is equivalent to a force at the mouth of the resonator directed normally inward. Then comes an original explanation of

*With the invention of Professor Webster's interferential apparatus this dearth has already become fruitful.

the effect of external influences in modifying vibrations, the former being grouped into such influences as modify pitch and those which encourage or discourage vibration. Thus in the latter case, an impulse would have to actuate a pendulum while passing through its position of equilibrium; in the first case the impulse must be applied at either elongation. The principle is illustrated in its bearing on the sounds frequently obtained in glassblowing, on the chemical harmonica, and on other similarly subtle methods of sound production. A second paper on absolute pitch accentuates the fact that two equations are given when the frequency-ratio and number of beats per second of two notes of a selected interval are given from which the absolute pitch of both may be computed. The inferences are tested with modifications by aid of the common harmonium. A new series of acoustic experiments deals with the production of pure tones from sounding flames on suitably modifying the resonator, with Savart's region of silence on reflection, with sensitive flames (which seem to fascinate Rayleigh as they did Tyndall and by which the remarkable investigations on jets above referred to were suggested), etc. Among the results we find that sensitive flames are excited at loops and not at nodes, that Rijke's notes (produced by heated gauze on cooling in a pipe) can be raised to an intensity sufficient to shake a room. Experiments are given on the effect of a barrier in promoting interference between the two halves of an organ pipe. In an ingenious experiment in which the chimney is made available as a source of draft, it is shown that the vibrations of the strings of an Æolian harp are at right angles to the direction of the wind. A final series of acoustic observations begins with the full discussion of Mayer's well-known experiment on intermittent sounds. After showing a new form of siren, an experiment is described for obtaining the interferential sound shadow of a circular disc, an analogue of the optical experiment. The last acoustical paper included is an explanation of the photophone.

The remaining papers of the volume are largely devoted to optics. We notice in particular a long and frequently quoted paper (1879–80) on the resolving power of telescopes with especial reference to spectroscopy.* Starting from the deductions of Airy, Verdet and others, Rayleigh computes the visibility curves for single and double lines, single and variously doubled slits. In an examination of the prismatic spectroscope it appears that the resolving power for a given glass is proportional to the total thickness traversed without regard to the number, angles or settings of the prisms. The aberration errors and the degree of accuracy required in the surfaces are abstrusely treated in detail and a final paragraph is devoted to the designing of the spectroscope. A subsequent theoretical paper deals with reflection when the transition at the boundary of two media is gradual and not abrupt as usually assumed by the great opticians (Fresnel, Green, Cauchy and others). Passing this and an experimental method (grating) of measuring the resolving power of telescopes, as well as another on the definition of images formed without lenses, we come to Rayleigh's first considerable papers (1881) on the electromagnetic theory of light. It would appear from this that Rayleigh like Kelvin was late in his acceptance of Maxwell's optics, certainly a regrettable circumstance by which the advance of science was retarded. It is the object of the present long investigation, to find an electromagnetic basis for Fresnel's optics, particularly in relation to reflection and to double refraction. In different ways Hemholtz, Lorentz, J. J. Thomson and others have all worked successfully at this problem. It is well known that to explain double refraction Fresnel postulated differences of rigidity of the ether in different directions; to explain reflection such a change of rigidity in passing from one medium to another is precluded. Neumann and MacCullagh have endeavored to obviate the inconsistency by replacing differences of rigidity by differences of density, but the elastic theory resulting is none the less imperfect. The electromagnetic theory of light based on radically different laws avoids these discrepancies at the outset. Naturally in Rayleigh's work the scattering reflection of moats is particularly considered as a test of

* In America, as we know, similar work has been remarkably promoted by the researches of Professor Michelson.

the equations deduced. In a following paper discussing Young and Forbes' experiments in which the velocity of violet light apparently exceeds the velocity of red light by 1.8 per cent., Rayleigh again accentuates the difference between the group velocity and the individual velocity of waves. The last optical paper in the volume reopens the question relative to the production of a truly compound yellow made of red and green, and treats other questions of similar psychological interest. The concluding paper of the book is an investigation in pure elastics, dealing with the infinitesimal bending of surfaces of revolution, with particular reference to the theory of bells.

I am of course well aware that the account which I have endeavored to give of this great book is altogether inadequate; but with such an exuberance of material, and so much of it expressed either in untractable equations or in a style admitting of expansion only, all attempts are foredoomed. Besides the larger papers which I have mentioned, there is a bewildering array of smaller articles, sententious criticisms or suggestions mathematical or not, theorems, special solutions, computations, etc. Some of Lord Rayleigh's most helpful services to science are to be found in these current notes and as a rule they are hard to find. For this reason the present complete republication of his works is additionally to be welcomed.

Rayleigh's style is exquisitely terse. Even those papers which are free from mathematics are not easy reading. The endeavor to make a clear statement more intelligible is rarely thought worth while. The greater number of papers are short. The average 7 pages each (78 papers in the 562 pages of this first volume). Withal it is a book to which one may come for fundamental originality, but one must expect to pay for the privilege. It is pleasant to note that Rayleigh cheerfully gives credit to the labors of others and not only to those of his own nation. But however genial his criticism it is none the less keen. Errors are virtually dismembered with a few deft strokes, and the incident passes before there is time to cry for mercy. On the whole a wise man will think twice before he disagrees with the author of these 'Scientific Papers.'

Lord Rayleigh is not quite as radical as some of the other English mathematicians in eschewing formulated mathematics as far as possible, a method which those of us who do not aspire to become too mathematical for mathematics, cannot but regret—at least when we have practical occasions for following the argument. There is moreover something amusing about this fashion of verbally treating abstruse mathematical doctrine. Our host, as it were, receives us at his ease, quite unarmed, and discusses the most delicate matters with complete nonchalance. But nobody is deceived. One may be quite sure that a strong man, armed cap-à-pie, is hidden away somewhere in the closet. When mathematics becomes verbal one feels that she is speaking a foreign tongue and that something is actually being translated. The original would be far preferable.

On closing the book one can not but wonder how much talk could be made out of a single page of it; or perhaps more graciously, how immensely science would be benefited if the bulk of what is now rampant were to shrink to the standard of Lord Rayleigh's text.

Carl Barus.

Brown University,
Providence, R. I.

System der Bakterien. By Professor W. Migula. Handbuch der Morphologie, Entwickelungsgeschichte und Systematik der Bakterien. Bd. II. Specielle Systematik der Bakterien. Jena, Gustav Fischer. 1900. Pp. 1068, pl. 18, figs. 35.

The working bacteriologist has long been in need of some treatise that would enable him to trace to the original description at least a fair proportion of the 'species' and 'varieties' that he finds referred to in the literature of the day. It is one of the great stumbling-blocks in bacteriology that a bewildering multiplication of names and synonyms has taken place during the last decade and has had its natural result in an almost hopeless confusion of bacteriological classification and nomenclature.

The great task essayed by Professor Migula may well command respect and admiration. Not only is enormous mechanical labor involved in the extracting and collecting of 1200 descriptions of bacterial species from many widely scattered books and special monographs, but the orderly arrangement of these descriptions, many of them imperfect and fragmentary, is a labor calculated to daunt any but Teutonic patience. That the task has been accomplished in such a satisfactory fashion by Professor Migula is matter for general congratulation.

There doubtless exist differences of opinion among bacteriologists as to how far systematists should carry out the process of welding together descriptions of species. There can be no question that many of the 'species' now masquerading under different titles are in reality identical and should be grouped under one name. On the other hand, it is equally true that forms now classed as 'varieties' are actually distinct and may be shown by future investigators to be widely separated. Two opposite tendencies are plainly visible among bacteriologists concerned in work of this character—and all bacteriologists are sooner or later brought face to face with the question of the 'identity' of the forms with which they are working: the tendency to magnify physiological differences and erect into new species or varieties those forms showing even slight divergence, and the tendency to ignore minor physiological characters and to include closely allied organisms under one species or group-name. Much more detailed study of the natural varieties of bacteria and of their plasticity under artificial conditions is necessary, however, before the true path can be surely determined.

The course pursued by Professor Migula in this matter is likely to command general approval. It will probably be more useful at the present stage of our knowledge to possess a convenient and accurate record of all descriptions by all writers than to have an elaborate tabulation that has been subjected to too much revision and consolidation. At the same time it may be questioned whether it is necessary or advisable to include in a work of the highest standard, descriptions glaringly imperfect and defective, so imperfect in fact that identification and evaluation are not now and never can be possible. The pages of the *System der Bakterien* might well be pruned of much dead and useless material of this nature.

The permanent value of a text of this sort can be thoroughly tested only by continual practical use, and it would be a work of supererogation to seek for the minor sins of omission and commission which any work dealing with bacterial classification must at present necessarily contain. One regrettable, but perhaps pardonable oversight only need be mentioned. The careful descriptions of a large number of water bacteria by two American bacteriologists, Wright (Memoirs National Academy of Sciences, VII., 1895) and Ravenel (Memoirs National Academy of Sciences, VIII., 1896) have evidently not come under the author's notice. Omissions of an important character are, however, surprisingly few and Professor Migula's great treatise will long remain the standard work in systematic bacteriology.

EDWIN O. JORDAN.

SCIENTIFIC JOURNALS AND ARTICLES.

Bird Lore for April opens with a description of 'A New Camera for Bird Photographers,' by the designer, John Rowley. 'Photographing a Robin' is described by A. L. Princehorn and 'How a Marsh Hawk Grows' is told by P. B. Peabody. In an article on 'The Egret Hunters of Venezuela,' George K. Cherrie shows the 'egret farms' of which we have heard are purely mythical and that the gathering of shed egret feathers is simply an incident in the work of the plume hunters. Marion E. Hubbard describes 'Bird Work at Wellesley College' and the balance of the number is given over to notes, correspondence, book reviews and reports of Audubon Department. The editor discusses the amendment to the law designed to protect non-game birds.

The Plant World for March begins with an amusing article on 'Popular Ignorance concerning Botany and Botanists,' by Aven Nelson T. H. Kearney discourses 'Concerning Saxifrages.' A. M. Curtiss tells of 'The Water Hyacinth in Florida.' A. Wetzstein of 'The Velvet Dogbane in Ohio,' and L. H. Pammel of 'The Twin-Leaf (*Jeffersonia diphylla*) in Iowa.' Under 'Plant Juices and their Commercial

Values,' Mrs. Caroline A. Creevy tells of tar, camphor, manna, opium and some perfumes. In the supplement devoted to the 'Families of Flowering Plants,' Charles Louis Pollard discusses the orders Pandanales, Helobiæ and Triuridales.

The *Mathematical Gazette*, the organ of the English Mathematical Association, will in future be issued six, instead of three times a year. The *Gazette* will contain articles suggestive of improvements in methods of teaching, or covering ground not satisfactorily treated in text-books, reviews of mathematical books, together with shorter notices of new text-books, elementary mathematical notes, problems, and other matter of direct interest to mathematical teachers.

Erythea, the Italian botanical journal, will be discontinued at the close of the present volume.

SOCIETIES AND ACADEMIES.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

The annual meeting was held on the evening of Monday, March 26th. Professor J. McK. Cattell was elected Chairman for the ensuing year. The Secretary of last year was continued in office.

Dr. A. L. Jones read a paper on 'The Symbolic Character of Geometrical Forms as a Principle of Explanation.' Among the attempts to explain formal beauty, that of Lipps in his 'Raumästhetik' is the most striking. He maintains that the æsthetical value of beautiful geometrical forms is due to the fact that they symbolize the activity of mechanical forces working themselves out freely; that we sympathize with the forces thus represented and receive pleasure when their action is unhindered; that the forces and laws of their action are not consciously recognized, but are merely *felt* or known unconsciously. His explanation involves some questionable metaphysics. The action of mechanical forces is no doubt an important element in many beautiful objects, but it remains to be proved that it is sufficient to explain all formal beauty in objects.

Dr. R. S. Woodworth presented a paper on 'The Fatigue of Voluntary Movement.' The fatigue of movement may be studied in reference to the loss in force, in accuracy, or in speed. In each of these respects experiments show that a movement may be continually repeated for hundreds and even thousands of times with only a comparatively slight loss of efficiency. The ergographic curve given by Mosso for force of movement is to be absolutely abandoned as a true picture of the curve of fatigue. This fact has been of late recognized in some able articles by Treves, working in Mosso's own laboratory; but it is best brought out by the use of Cattell's spring ergograph. One of the great causes of fatigue in force (and also in speed) of movement is the failure of the muscles to relax completely between successive contractions. If care is taken to secure this relaxation, 1000–1500 maximal ergographic contractions can be made with a loss of only 10 per cent. of the initial force. From the slowness of fatigue of various modes of voluntary movement, the inference follows that the fatigue of nerve centers is not rapid, as Mosso and Lombard have supposed, but slow in progress. This view is confirmed by tests of prolonged, hard and monotonous work of a mental kind. The quick and overmastering fatigue of common experience is not so much actual inability and loss of function as it is disinclination, resulting from disagreeable sensations and emotions and from impulses to change.

The third paper, given by Dr. Thorndike, was on 'Weber's Law in Judgments of Comparison with a Mental Standard.' This paper presented the results of some experiments on the accuracy of discriminations of weight, length and area, by subjects who judged by the aid of mental standards only. Within the limits chosen (40–120 gr., ½–12 ins., 20–60 sq. cm., and 2–12 sq. ins.) the accuracy of discrimination was found to decrease very slowly, very much more slowly than Weber's law or even the law of the combination of errors would allow. The theory proposed to account for this was that our judgments of amount or of difference are of complex origin, and may be made on various grounds. In so far as the ground is an accurate mental standard the sensations corresponding to large amounts may be associated with the proper judgment nearly or quite as readily as small amounts. In so far as the ground is a combination of feelings or judgment, the inaccuracy of a judgment may vary, because of the combination of errors, as the square root of the amount. In so far as the ground is the mere mental shock of difference, the inaccuracy of the judgments may vary in some more direct relation to the amount.

CHARLES H. JUDD, *Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 321st meeting was held on Saturday, March 24th. Barton W. Evermann exhibited a series of proofs of the colored plates prepared to illustrate a forthcoming report on the fishes of Puerto Rico. Sylvester D. Judd described some 'Feeding Experiments with Captive Birds,' illustrating the difference between the methods of the Broad-winged Hawk and Shrike in killing and eating their prey. The habit of impaling its prey on thorns, employed by the Shrike, was considered to be due to the weakness of its legs which prevented the bird from holding and tearing its prey after the manner of the Hawk.

W. H. Osgood presented some 'Notes on a Trip Down the Yukon River' describing the character of the river in different portions of its course and the geological aspect of the banks. The various life regions through which it flowed were pointed out and their faunal and floral peculiarities were stated.

H. J. Webber discussed 'The Influence of Pollen on the Fruit of the Current Year,' describing two crucial experiments where the color and chemical constitution of corn had been changed as a result of the immediate influence of pollen or xenia. In one case sweet corn, which had been bred true to type for three generations, when crossed with yellow dent corn produced ears having smooth yellow dent kernels with starchy endosperm like the male parent. In the other case Hickory King, a white dent corn, with a large portion of corneous endosperm, grown from seed inbred the previous year and known to be pure, when crossed with Cuzco a plumbeous colored soft flour corn produced kernels of plumbeous color or with plumbeous colored spots and little corneous endosperm in these characters resembling the male parent.

F. A. Lucas spoke of 'The Tusks of the Mammoth' saying while the animal was usually represented with the tips of the tusks flaring outward there was good reason to believe that the tusks pointed inward at the tips as in the modern elephants. He illustrated his remarks with photographs of different specimens including one 12 feet 10 inches long, from Alaska believed to be the longest tusk on record.

F. A. LUCAS.

GEOLOGICAL SOCIETY OF WASHINGTON.

THE 100th regular meeting was held at the Cosmos Club, March 28, 1900.

The program for the evening comprised a 'Symposium on Field Methods,' illustrated by notebooks, maps and instruments used in each class of work. The following contributions were presented:

M. R. Campbell and A. Keith—Appalachian Methods.

T. W. Vaughan—Great Plains Methods.

G. O. Smith—Lake Superior Methods.

J. D. Irving—Adirondack Methods.

J. E. Spurr—Reconnaissance Methods in the Great Basin.

A. H. Brooks—Reconnaissance Methods in Alaska.

W. Cross—Rocky Mountain Methods.

H. W. Turner—Sierra Nevada Methods.

F. L. RANSOME,
DAVID WHITE,
Secretaries.

DISCUSSION AND CORRESPONDENCE.

'NEW-DARWINISM.'

TO THE EDITOR OF SCIENCE: In a review of my book 'Darwinism and Lamarckism' (G. P. Putnam's Sons) in SCIENCE for December 29, 1899, Mr. C. W. Hargitt objects, perhaps rightly, to my using the term 'New-Darwinism,' in a sense different from that in which it has been used by many biologists. I quite agree with him that I ought to have given my reasons for thus using the term and I shall feel obliged if you will allow me to give those reasons now.

About ten years ago Dr. A. R. Wallace published a book on the theory of Natural Selection, and about the same time Professor Weismann published an essay on heredity. Both advocated natural selection as the sole cause of organic evolution and pronounced the inheritance of acquired characters to be impossible. Mr. Wallace called his book 'Darwinism.' In time these opinions were called the 'New Darwinism,' although some of them were quite at variance with those always held by Darwin up to his death.

A little later Dr. Romanes' book called 'After Darwinism' appeared, in which he amplified the views held by Darwin in a way to which, I think, Darwin himself would have agreed. This also has been called by some the 'New-Darwinism' with, as I think, a much better right to the title than those advocated in Wallace's book, which should have been called Wallaceism. I object to Mr. H. Spencer and others using the term New-Darwinism for Wallace's opinions; for, when it is shown that these are wrong, the unscientific public will naturally conclude that Darwin was also wrong, although he would himself have repudiated this New-Darwinism.

F. W. HUTTON.

CANTERBURY MUSEUM,
CHRIST CHURCH, NEW ZEALAND,
February, 21, 1900.

'THE ESKIMO OF SMITH SOUND.'

TO THE EDITOR OF SCIENCE: The attention of the readers of SCIENCE is specially invited to a pamphlet of sixty pages, published by the American Museum of Natural History, entitled 'The Eskimo of Smith Sound,' by A. L. Kroeber. The Smith Sound Eskimo stand ethnologically between those of Greenland and the Central Eskimo and form a transition from the latter to the former. The theory of Holm that the Angmagsalingmiut (East Greenlanders) reached their present abode by following the ice-bound shores of Northern Greenland, is held to be untenable. Again, in examining Kroeber's illustrations, the opinion long ago published by this writer that no unsophisticated Eskimo ever etched on bone, ivory or antler is sustained. The small amount of engraving present is evidently the work of steel tools.

But, most interesting of all the accounts in the pamphlet is that concerning the loss and recovery of the kaiak. These Smith Sound Eskimo were discovered by Sir John Ross, in 1818, and were afterwards visited by Franklin, Kane, Hayes, Hall and others. Now, none of the explorers saw kaiaks in the sound. The art of building them had apparently been forgotten, though the word 'kaiak' remained in the language. From the time of Ross abundance of material for the structure was at hand, the environment was there begging for kaiaks, but the culture-hero had to come and teach them their own lost art. Between 1868 and Peary's visit the Adlet (Ellesmere Land Eskimo) had furnished the culture-hero and now the fisherman recovers his skill. The arts of the Smith Sound Eskimo are clearly set forth and compared with the Central tribes of Boas, and the traditions given at length.

O. T. MASON.

A CHRONOLOGICAL INDEX.

TO THE EDITOR OF SCIENCE:—Every scientific writer who has read with open mind the entreaties of recent writers on the subject has already adopted the plan of giving the year (as well as the volume) of any journal to which he has occasion to refer; few people wish to look up the reference (only those who are about to write on the subject), but every one who reads the article at all is interested in knowing the date of the contribution to the subject referred to—often, in fact, the reference wholly loses its point from a lack of this knowledge. Since, moreover, there are still many scientific writers who do not belong to the above described category, I wish to suggest that it would be a work of very great value if some one would issue a finding list, covering several hundreds of the principal scientific journals, which would enable the reader to pass at a glance from volume to year. Such a list would involve very little trouble on the part of whoever would be so good as to make it up, and it would certainly be a very great convenience. It might be printed on separate cards for separate subjects, and the scientific reader could have these cards (or as many of them as interested him) always at his elbow.

If both year and volume cannot be given when articles are referred to (for economy of space—there can be no other reason), it seems plain that the year is by far the more important of the two. The only inconvenience that could arise from not knowing the volume would be that in the case of those journals in which the volume does not begin with the year it might sometimes be necessary to take down from the shelf two books instead of one before the right place is found—an inconvenience of the very slightest kind. Of course every really virtuous scientific writer now gives his full references at the end of his paper, with year and volume both, and refers to them in the body of his paper thus — Déjerine-Klumpke, '94, III.— when the reference is to the third paper issued by Déjerine-Klumpke in the year 1894. Pending the attainment of perfect virtue on the part of writers (and also for the convenient reading of all articles of the past), I submit that a table of cross-references, such as I have described, would be a work deserving of heartfelt gratitude on the part of an overworked scientific world.

C. L. F.

[A chronological table giving the year in which each volume of 550 scientific journals was published is included in the 'Catalogue of Scientific and Technical Periodicals,' by Dr. H. Carrington Bolton, the second edition of which was published by the Smithsonian Institution in 1897.—Ed. Science.]

THE INTERNATIONAL CONGRESS OF MECHANICS.

To the Editor of Science: M. Marcel Delmas, 10 Boulevard Emile Augier, Paris-Passy, has charge of the report of the 'Congress de Mecanique de l'Exposition universelle,' in the department of applications of electricity to the various apparatus of haulage, hoisting, etc. (including cranes, elevators, winches, swing-bridges, pumps and other such mechanisms), and particularly desires information regarding the economic side of the matter. He requests that all, whether intending exhibitors or others, who are willing to assist in the collection of this data, send him, at the address given above, statements of costs of installations, of exploitation and incidental expenses, especially where a comparison can be made with costs of the older systems under similar circumstances. All publications and illustrations will be welcome, if authentic and exact in statement of facts and data.

R. H. Thurston.

NOTES ON PHYSICS.

LIQUID AIR.

C. Linde gives some interesting data on liquid air in the *Physikalische Zeitschrift* for January 6, 1900. He calls attention to the fact that the commercial use of liquid air depends in the first place upon the amount of energy consumed in its production and upon the length of time that the liquid can be kept before it is used. With small machines from 3 to 4 horsepower—hours are used per kilogram of liquid air, while the largest machine hitherto built, produces fifty kilograms of liquid air per hour and consumes about 100 H. P. This latter corresponds to an efficiency of 15% as compared with what a perfect thermodynamic machine would accomplish.

Small quantities (about one liter) of liquid air in vacuum jacketed and silvered vessels are lost by evaporation in about 14 days. In large tin vessels (50 liters) covered with hair felt about two liters per hour is lost by vaporization. The author gives data concerning the use of liquid air for refrigeration and for power. When extremely low temperatures are desired liquid air is perhaps the best possible means for producing it. On the other hand from twenty to forty times as much energy is consumed in producing moderate refrigeration by liquid air than is required in the ordinary ammonia refrigerator. Thus a kilogram of liquid air evaporated in a room reduces the temperature of the room only about as much as the melting of two kilograms of ice, and two kilograms of ice may be produced by the evaporation of 1/20 horsepower-hour or less.

When liquid air as evaporated at ordinary temperatures and used to drive a motor, the work developed by the motor is only about three or four per cent. of the energy consumed in the production of the liquid air. The author however points out special cases where the use of liquid air for power might be desirable.

The author mentions some experiments which have been made in the Simplon tunnel, now building, to test the usefulness of a mixture of liquid air or liquid oxygen and mineral oil (soaked up in powdered charcoal) as an explosive. These experiments have not fully determined the usefulness of this cheap explosive, the principal difficulty being that the mixture changes its composition rapidly as the nitrogen and oxygen evaporate.

The author suggests that the most promising field for liquid air machines is in their use for separating (partially) the oxygen from the large amount of nitrogen with which it is associated in the atmosphere.

ATMOSPHERIC ELECTRICITY.

AT last we have a reasonable theory of atmospheric electricity based upon facts. Elster and Geitel, and independently J. J. Thomson and C. T. R. Wilson, have applied the known properties of ionized gases to the explanation of atmospheric electricity. The sun's light, especially the ultra violet rays, ionizes the atmosphere producing equal numbers of positively and negatively charged ions. These ions are ordinarily present in equal numbers in dry air and their charges do not therefore develop any perceptible electric potential. When the air is cooled below its dew point, however, the negative ions mainly serve as nuclei upon which the moisture is condensed in drops which in falling remove the negative ions, leave an excess of positive ions; this excess of positive ions gives rise to very great electric potentials, and produces the electrical effects which accompany rain. The reasonableness of this theory is that every physical action which enters into it has been followed in the laboratory—the ionization of air by ultra violet light, the condensation of moisture on the negative ions, etc.

W. S. F.

CURRENT NOTES ON PHYSIOGRAPHY.

GLACIAL LAKES IN WESTERN NEW YORK.

FAIRCHILD has extended his studies of glacial lakes to the Finger lake district of western New York, and presents a comprehensive sketch of nineteen valleys in which such lakes were formed, several of them showing shore lines at successive levels (*Bull. Geol. Soc. Amer.*, X., 1899, 27–68). The southward overflows of the lakes, leading over passes between the hills of the Allegheny plateau to the different headwater streams of the Allegheny and Susquehanna rivers, are enumerated and figured. The eastward outlets, between the northern slope of the plateau and the retreating front of the ice, previously described by Gilbert and Quereau, are here beautifully illustrated; they prove to be even stronger topographic features than the channels of similar origin carved in the drift of eastern Michigan, as described by Taylor.

Reference should be made in this connection to a thesis on 'Some higher levels in the post-glacial development of the Finger lakes of New York State,' submitted by T. L. Watson, a graduate student in Cornell University in 1897 (Rept. Director N. Y. State Museum, 1898, App. B, 65–117).

THE POMMERANIAN COAST-LAND.

DETAILS concerning the course of valleys formed by rivers marginal to the retreating ice of north Germany recently given by Keilhack (Die Stillstandslagen des letzten Indlandeises und die hydrographische Entwickelung des pommerschen Küstengebietes, Jahrb. k. preuss. geol. Landesanstalt, 1899, 90–152, 14 maps) supplement the general account referred to in SCIENCE for January 5, 1900. After the ice sheet had withdrawn from the morainic hills of the Pommeranian lake belt, twelve successive stages of constrained drainage are recognized and mapped, interrupted terminal moraines having been formed during some of the stages, and special conditions of marginal drainage having characterized every one of them. The important valleys eroded in the uplands by rivers marginal to the retreating ice are analogous to those above described, in the northern spurs of the Allegheny plateau of west central New York. If any one desires novel evidence of the former existence of land ice-sheets, and of their importance in fashioning, directly, or indirectly, existing geographical features, it may be found in abundance in the two districts here referred to.

GERMAN PHYSIOGRAPHIC TERMS.

A CHAPTER on the Earth's Surface, written by Penck for Scobel's 'Geographisches Handbuch zu Andrees Handatlas' (3d ed., 1899), presents a compact epitome of the physiography of the lands, in which the German equivalents for a number of English terms may be found. The cycle of denudation (Umbildungscyklus) opens with initial forms (Urformen) produced in the large way by deformation (Grossformen, Strukturformen), such as masses of vertical movement (Schollenländer) with raised blocks and rift valleys (Horste, Graben), or folded zones (Stauungszone) with arches and troughs (Rücken, Thalungen). Destructive agencies carve the details (Kleinformen, Skulpturformen) of consequent and subsequent features (Folgeformen, Unterfolgeformen) such as are seen in regions of young and mature valleys (jugendliche, ausgereifte Thallandschaften). The diversion (Ablenkung) of one stream by another causes a migration of divides (Wanderung der Wasserscheiden) and results in an adjustment (Anpassung) of streams to structures; initial, consequent, and subsequent divides (Ur-, Folge-, Unterfolgescheiden) may therefore be recognized. As the valleys widen and consume the hills, old age (Alter der Landschaflen) is reached, ending in a peneplain (Rumpflandschaft). It is possible to combine cycles of different stages (Stadien), the sequential forms (Skulpturformen) of the first cycle having served as the initial forms (Urformen) of the next. Some of Penck's terms, such as Schichtstufen, Schichtkammlandschaft, Durchbruchthal, have no simple equivalents in English.

LAKES OF THE BÖHMERWALD.

EIGHT small lakes occupy corrie-basins in the Böhmerwald. Their physical features are described and their origin is discussed by P. Wagner (Die Seen des Böhmerwaldes, Wiss. Veröffentlichungen, Verein f. Erdkunde, Leipzig, iv., 1899, 1–90, maps, sections and views). After a general consideration of the various theories as to the origin of corries (Karen, Cirques, Botner) through erosion by water, obstruction by rockfalls, and excavation by névé and ice, the author concludes that the best developed corries, with background of cliffs and rounded basin of clean-scoured rock, are valleys of preglacial erosion modified by snow and ice action during the glacial period.

W. M. DAVIS.

CURRENT NOTES ON METEOROLOGY.

DEATH OF MR. G. J. SYMONS.

MR. GEORGE JAMES SYMONS, who died in London on March 10th, was well known throughout the meteorological world as the founder and head of the British Rainfall Service. In 1857 he started an organization for observing and recording thunderstorms, and soon afterwards began his life work on British Rainfall, which he continued till his death. The observers co-operating in this undertaking now number between 3000 and 4000, and the results of the observations have been published annually in successive volumes, bearing the title *British Rainfall.* The first volume contained the records for the year 1860, and the fortieth is shortly to be issued. Mr. Symons occupied a unique position, that of a private individual in charge of a great meteorological service, which he himself built up and administered. In 1866 Mr. Symons began the publication of his *Monthly Meteorological Magazine*, to which reference has from time to time been made in these NOTES. His name is further well known in connection with the meteorological section of the Royal Society's Report on the Krakatoa eruption, and with his valuable contributions to meteorological bibliography. He rendered important assistance in the preparation of the *Bibliography of Meteorology*, published by the U. S. Signal Service. Mr. Symons was a Fellow of the Royal Society, a member of the General Committee of the British Association, President of the Royal Meteorological Society, and for 27 years the Honorary Secretary of that Society. He was created a Chevalier of the Legion d'Honneur in 1891, and was selected by the Prince of Wales to receive the Albert Medal of the Society of Arts for 1897, "for services he rendered to the United Kingdom by affording to engineers engaged in the water supply and sewerage of towns a trustworthy basis for their work by establishing and carrying on during nearly 40 years systematic observations (now at over 3000 stations) of the rainfall of the British Isles, and by recording, tabulating, and graphically indicating the results of these observations in the annual volumes published by himself." Meteorology can ill afford to lose so unselfish a worker as Mr. George J. Symons.

THE MISTRAL.

The *mistral* is well known as a strong cold wind which is common in the region about Marseilles, in southern France. It occurs when there is a barometric gradient to the south from the plateau of Central France, the cold air flowing quickly down the gradient and producing what the Germans have well named a *Fall-wind.* In the districts which are subject to frequent mistrals, the trees are bent to the southeast under the influence of the strong northwest wind, and the gardens are protected by means of high walls. The mistral is often so violent as to cause considerable damage, and sometimes even loss of life. Kassner, in *Das Wetter* for February, mentions the case of a mistral which occurred on January 20th, of this year. A carriage in which a lady was driving was blown into a canal, and the passenger and horse were drowned. One man was severely cut in the head by a tile which was blown from a roof, and another was thrown down by the wind and badly hurt. In view of the accident to the carriage above referred to, the mayor of Marseilles issued an order to the effect that hereafter no carriages are to be allowed to drive along the canals or the water-front while a mistral is blowing. Ordinary street traffic in Marseilles is always considerably interfered with by a violent or a long-continued mistral.

TYPHOONS OF THE PHILIPPINE ISLANDS.

The Manila Observatory, under the direction of the Jesuit Fathers, has been keeping on with its excellent meteorological work throughout the troublous times of the past two years or more. The latest publication which has come to hand from the Observatory is a report by Father Doyle, entitled, *Tifones del Archipielago Filipino y Mares circunvecinos 1895 y 1896.* This is a valuable extension of the work already done by the Manila Observatory in connection with the typhoons, or *baguios*, of the Philippine region, and is a fitting supplement to Father Algué's report, *Baguios ó Ciclones Filipinos*, dated 1897. The present report gives a detailed account of the different typhoons, with tabulated meteorological observations relating to them. The tracks are plotted on a series of eight maps, and the fluctuations in atmospheric pressure noted during the passage of three special typhoons are represented graphically.

CLIMATE AND MILITARY OPERATIONS.

The Influence of Climate on Military Operations is the title of a chapter in a recent work on *Outlines of Military Geography*, by T. M. Maguire (Cambridge, Eng., 1899, Cambridge Geographical Series). Dwellers on plains are compared with dwellers in mountainous regions; the severity of the seasons is noted in connection with Napoleon's Russian expedition and other military campaigns, and the subject of disease among troops is also touched upon.

R. DeC. Ward.

Harvard University.

PATENTS AND THE INDUSTRIES.

The recently published report of the U. S. Commissioner of Patents is a reminder of the facts that this system of protection of the inventor and of assurance to him of the product of his brain, a system to which those familiar with the subject attribute a large share of our unexampled progress in the arts and industries, has, of late years, received far less consideration than formerly and that it has not been cared for as it should be. It is the most remarkable stimulant to invention that the world has yet seen, and to it the country owes more than can be either estimated or compensated. Yet apparently neither the committees to which its interests are entrusted, nor the Congress itself gives much consideration to its needs or its deserts. Nearly 50,000 applications for patents on new inventions have been recorded in a single year. The receipts of the office were last year far above its expenditures—$1,325,457 and $1,-211,783—and this has been the fact in every year of its century of existence, with the exception of but eight. In 1883, the surplus for the year amounted to about a half million dollars. The total balance of the Patent Office to-day amounts to $5,086,649; but Congress does not even permit this earned capital to be appropriated to the needs of the Patent Office. It has a wealth of resources and is annually adding to them; yet it is permitted to need additions to its staff of examiners, to suffer for lack of additions to its library, which should be the finest technical library in the world, to need larger and better quarters for its work, and it is even crowded in its own building by squatting bureaus of the Treasury Department Land Office.

The report on the number of patents issued in 1899 gives the number from New York as 3798; Pennsylvania, 2355; Illinois, 2152; Massachusetts, 1774; Ohio, 1501. Connecticut, however, as famous as ever in this direction, leads the list in inventiveness, securing one patent to each 945 inhabitants; the District of Columbia, curiously enough, but probably by a legal fiction, follows with 1 to every 1151, Massachusetts with 1 to each 1261 people, Rhode Island with 1 to 1270, New York coming in as number eight, with 1 to 1579. South Carolina ends the list with 1 to 25,024 people and North Carolina is next with 1 to 21,012. New England, as always, stands in the van, for the United States and the world, in inventiveness.

Of other countries, Great Britain leads, Germany stands next, and France is third in the list of foreign patentees in the United States Patent Office.

In performing their work of research, to solve the question of originality on the part of the inventor, the examiners have to seek among 700,000 earlier United States patents, 1,250,000 foreign patents and 74,000 published volumes of inventions and scientific and industrial treatises. But, as the Commissioner states, "The lack of suitable room greatly hampers and unnecessarily delays the work in many divisions."

This is now the regular and invariable general formula of the report of the United States Patent Office. It has been thus for many years past; exhibiting an enormous amount of work, performed under most unfavorable conditions; giving our country the leading position in invention, and in many industries; promoting the wealth of the nation enormously; earning an annual surplus; yet refused the use of its own earnings even to provide imperatively needed space and equipment, and forbidden even to add to its own library, its most essential tool, or to dispose of duplicate and useless books in exchange for others more needed.

Through the efforts and the genius of our inventors, the cost of products in every department of industry has been reduced to a fraction of the figures of a generation ago; the work of one man had been made more effective than was then the work of, in some cases, a dozen, and the wealth of the country is, by these means, being augmented, and all its attendant comforts and privileges increased to the average citizen, at the rate of one hundred per cent. in a generation. Yet the inventor is ungratefully neglected, and Congress devotes itself to 'politics' rather than statecraft.

Many organizations, and hundreds of individual citizens, made aware of these discreditable facts, are urging upon members of Congress to give proper attention to the Patent Office; but it apparently will require more pressure than the American Society of Mechanical Engineers, and all the other national associations seeking to promote this reform, can exert to insure attention to a primary duty. Every citizen has an interest in this matter, and should do what he can to bring about a reform in Congress, and the provision for the Patent Office of every need and convenience.

R. H. Thurston.

BRINTON MEMORIAL CHAIR IN THE UNIVERSITY OF PENNSYLVANIA.

Scholars the world over are appreciative of the achievements of the late Daniel Garrison Brinton for he established on a firm basis the branches of learning to which he devoted his life. He is justly named the 'Founder of American Anthropology.'

A close student of the intricate problems of his science, he possessed the rare art of clearly and concisely presenting facts at their true values. He believed in 'The general inculcation of the love of truth, scientific, verifiable truth' and that knowlege should subserve usefulness.

A keen observer, a classical scholar, an adept in the methods of logic and philosophy, Dr. Brinton had ever the practical application of truth in view. To the systematic study of man he brought to bear his all rounded culture to further the happiness and fullness of the individual life. He regarded the individual as the starting point and goal of anthropology. Upon individual improvement, he claimed, depended group or racial improvement, social amelioration, and the welfare of humanity.

Anthropology, the New Science of Man, in Dr. Brinton's own words "is the study of the whole of man, his psychical as well as his physical nature, and the products of all his activities, whether in the past or the present."

This broad comprehension indicates the significance of anthropological study. Its limits of attainment are limited only by the nature of man himself, and Dr. Brinton asks "who dares set a limit to that?"

Although the youngest of the modern sciences anthropology is none the less one of the most important of the sciences, for in its development is bound closely the progress of society. To carry out the aims of anthropology are required the results obtained from the study of ethnography, ethnology, psychology, folk-lore and archæology—more especially pre-historic archæology which concerns itself not only with the ancient but with 'the simplest' and 'most transparent and therefore the most instructive.'

Notwithstanding the extension of this work in America, comparatively few professorships of anthropology or its branches exist, and the limited opportunity afforded students to qualify themselves for investigation in these various subjects is manifest. Dr. Brinton pointed out the insufficiency of facilities for students to acquire the necessary preliminary training to fit them for research, and he advocated and urged that anthropology should be studied generally in our colleges. Provost Harrison referred to this in his address at the Brinton Memorial Meeting held in Philadelphia in January last, and stated that Dr. Brinton had the utmost confidence in anthropology as a science and also in its practical worth as an applied science in politics, education and legislation.

It is proposed in recognition of the great services he rendered to the world by his teachings, numerous publications, and untiring zeal in unearthing the false and proclaiming the true, to establish in his memory a Brinton Chair of American Archæology and Ethnology in the University of Pennsylvania.

This proposition has received the universal commendation and approval of anthropological scholars both in Europe and America.

At the Memorial Meeting the plan was favorably mentioned and grateful recognition accorded to Dr. Brinton's unselfish devotion to his chosen life work. Provost Harrison thought that to honor his memory no more worthy tribute could be given than the foundation of a Brinton Memorial Chair in the University of Pennsylvania. Professor Putnam, following these remarks, said that he trusted the suggestion would not be dropped but that something tangible would come from Provost Harrison's words.

The choice of this place for the seat of the Brinton Memorial seems especially appropriate since the University of Pennsylvania now possesses Dr. Brinton's valuable library, his own gift shortly before his death. The association of Brinton's name with the University from 1886, when the chair of American Anthropology and Linguistics was created for his occupancy, may in this way be made permanent.

In order to accomplish the proposed plan, it will be necessary to secure an endowment of fifty thousand dollars from individual sources. Patrons of science and others interested in the endowment may apply to the Brinton Memorial Committee, 44 Mount Vernon Street, Boston, Mass., where further information is to be obtained if desired.

Messrs. Drexel & Co., bankers, Philadelphia, have kindly consented to act as Treasurers on certain conditions which will be explained to contributors on application to the Brinton Memorial Committee.

SCIENTIFIC NOTES AND NEWS.

The annual stated meeting of the National Academy of Sciences will be held next week beginning on Tuesday, April 17th.

At the annual meeting of the Astronomical Society of the Pacific, held in San Francisco, on March 31st, the Bruce Gold Medal of the Society was awarded to Dr. David Gill, H.M. astronomer, at the Cape of Good Hope. This is the third award of this medal.

Dr. Alexander Agassiz has returned to the United States from his expedition to the

South Sea Islands. The *Albatross* is still at Yokohama.

MAJOR J. W. POWELL, director of the Bureau of American Ethnology, and Professor W. H. Holmes, head curator of the U. S. National Museum, have just returned from an archæologic tour through Cuba and Jamaica. They succeeded in obtaining important data relating to lines of culture migration in this region, and especially to the connection between the Caribs of the South American continent and the aboriginal tribes of the West Indies and Florida.

DR. J. WALTER FEWKES, of the Bureau of American Ethnology, has just completed a successful season's work among the Hopi Indians. He has observed all the winter ceremonies of the tribe, a part of which have never before been studied, and his notes are accompanied by full series of photographs, diagrams, etc., as well as collateral records bearing on the general ethnology of the tribe.

THE board of directors of the Astronomical Society of the Pacific have elected Dr. J. E. Keeler, director of the Lick Observatory, to be president of the Society, and Mr. Chas. Burckhalter of the Chabot Observatory, to be first vice-president for the ensuing year.

M. DRAKE DEL CASTILLO has been elected president of the Botanical Society of France.

AT the next convocation of McGill University, Montreal, Mr. J. F. Whiteaves, F.G.S., paleontologist and zoologist to the geological survey of Canada, is to have the degree of LL.D. conferred on him by that University *honoris causa*.

AT the same convocation, Mr. A. G. Barlow, M.A., of the same survey, will receive the degree of Doctor of Science *in course*. His researches in the Archæan of Canada have placed Mr. Barlow in the foremost ranks of North American geologists. A synopsis of his latest report on the geology and resources of the Lake Temiskaming and Lake Nipissing country of Canada appeared in a recent issue of SCIENCE.

ALEKSANDR O. KOVALEVSKIJ, St. Petersburg; J. A. Gaudry, Paris; P. G. Tait, Edinburgh; J. H. van't Hoff, Berlin and J. J. Thomson, Cambridge, have been elected members of the Royal Irish Academy.

DR. B. M. DUGGAR, of Cornell University, has been appointed by the authorities of the Smithsonian Institution to the table for research, which that institution supports at the Statione Zoologica, Naples, Italy. He has already entered upon his work there.

FRANK HAMILTON CUSHING, ethnologist in the Bureau of American Ethnology, died on April 10th, at the age of forty-three years.

THE death is announced of M. Joseph Bertrand, professor of physics in the Collège de France and permanent secretary of the Paris Academy of Sciences.

DR. E. J. LOWE, F.R.S., known for his important contributions to meteorology and natural science, died at Chepstow, on March 10th, aged 75 years.

WE also note with regret the following deaths among German men of science: Dr. G. Karsten, professor of physics at the University of Kiel, aged 79 years; Dr. Elwin Bruno Cristoffel, late professor of mathematics at the University of Strassburg, aged 70 years, and Professor Teichmann, professor of mechanical engineering at the Technical Institute at Stuttgart, aged 61 years.

THE British Association for the Advancement of Science will hold its seventieth annual meeting at Bradford, beginning Wednesday, September 5th. Sir William Turner, F.R.S., will preside, and the presidents of the sections will be as follows: Mathematical and physical science, Dr. J. Larmor, F.R.S.; chemistry, Professor W. H. Perkin, F.R.S.; geology, Professor W. G. Sollas, F.R.S.; zoology (and physiology), Dr. R. H. Traquair, F.R.S.; geography, Sir George S. Robertson; economic science and statistics, Major P. G. Craigie; mechanical science, Sir Alexander R. Binnie; anthropology, Professor John Rhys; botany, Professor Sydney H. Vines, F.R.S. The two evening discourses will be delivered by Professor Francis Gotch, F.R.S., on 'Animal Electricity,' and Professor W. Stroud, on 'Range Finders.'

THE American Physiological Society will hold its fifth special meeting in Washington on Tuesday, Wednesday and Thursday, May 1, 2 and

3, 1900, as one of constituent societies of the Fifth Congress of American Physicians and Surgeons. The usual smoker will be held on Monday evening, April 30th. The headquarters of the Society will be at the Hotel Wellington.

THE annual general meeting of Chemical Society, London, was held on March 20th. At this meeting the Longstaff Medal was presented to Professor W. H. Perken, Junr., F.R.S. In the evening the Bunsen Memorial Lecture was delivered by Sir Henry E. Roscoe, F.R.S.

W J McGEE, ethnologist-in-charge, Bureau of American Ethnology, has just completed a course of three lectures on modern anthropology at Howard University, Washington. The special topics and dates were (1) 'The Stages of Culture,' March 15th; (2) 'The Rise of Civilization,' March 22d; and (3) 'The Dawn of Enlightenment,' March 29th.

DR. EDWARD CAIRD, master of Balliol College, Oxford, who was formerly professor of moral philosophy at Glasgow University, has been nominated as Gifford lecturer in the latter university, in succession to Sir Michael Foster, M.P.

UNDER authority from the Director of the Marine Biological Laboratory, Dr. C. O. Whitman, the Association for Maintaining the American Women's Table at the Zoological Station at Naples, offers for the summer of 1900 the free use of an investigator's table at the Laboratory at Woods Holl to any well qualified applicant who may desire to secure the benefit of preliminary training at Woods Holl, before applying for the American Women's Table at Naples. Applications for the Woods Holl Table should be made before May 1st, to the Secretary of the American Women's Table at Naples, Miss Florence M. Cushing, No. 8 Walnut street, Boston, Mass.

THE *Ninth Annual Report* of the British Society for the Protection of Birds, which now has a membership of 22,000, shows that its work extends effectively even to China, India and New Guinea. In the *résumé* of the year's work we learn that the wearing of osprey (egret) plumes has been discontinued by the officers of the Hussar and Rifle Regiments and of the Royal Horse Artillery, and also by the Viceroy's Bodyguard, of India.

WE noticed the destruction of the observatory at Tananarivo, Madagascar, in 1895 as a result of the French campaign. Dr. Tiessen's bureau reports that the French Government of the colony has appropriated 10,000 fr. for repairs which are being carried on under the director, M. Collin.

THE Pasteur Institute, Paris, has received 100,000 fr. by the will of the late M. Crevat-Durand.

PROFESSOR E. A. SCHÄFFER has been given a grant of £100 from the Earl of Morray endowment fund for physiological research.

MR. WILLIAM M. JOHNSON has offered to give the town of Hackensack, N. J., a plot of ground and a library building to cost from $30,000 to $40,000 on condition that the library be supported by the town.

Nature states that the Lemaire scientific expedition has reached Tenka, after a successful and peaceful journey of 3000 kilometres along the border of the Congo State. Three days east of Lualaba Mission the expedition met Major Gibbons, who was on his way to Tanganyika, *via* Lafoi, and thence to the Nile.

Two of the largest recorded tusks of the African elephant have recently been brought to New York from Zanzibar, and Mr. Kaldenberg, the well known dealer in ivory, states that the accounts recently published in the daily papers concerning them are substantially correct. One tusk weighs 225 pounds the other 239 pounds, weights that will probably exceed those of any tusks of the mammoth, if not indeed those of any species of elephant yet noted.

THE committee on Public Lands of the House of Representatives in Congress is considering the bill prepared on behalf of the Committees of the American Association for the Advancement of Science and the Archæological Institute of America for the preservation of prehistoric monuments, ruins, etc., etc., on the public domain, by reserving the lands on which they stand from entry and sale. The bill has been referred to, and is now in the hands of a sub-committee consisting of Messrs. Shafroth of

Colorado, Moody of Oregon, and Jones of Washington. The members of the two societies, and citizens interested with them, may materially assist in securing some affirmative action if they will signify their desire in person or by letter to any Member of Congress with whom they may be acquainted.

THE appropriation bill for the U. S. Agricultural Department, reported to the House, April 7th, carries $4,116,400, being $390,778 more than was allowed for the current year. Two additional scientific appointments (one biologist and one botanist) have been allowed. An additional allowance of $40,000 for seed distribution is granted upon the petition of 225 members of the House; $60,000 is appropriated for iron warning towers for the weather bureau in place of the present wooden structures; $38,000 for an animal quarantine station at New York; $47,000 additional for meat inspection and $200,000 for a laboratory building on the grounds of the Agricultural Department in Washington. This building is for the laboratories necessary to carry on the work of the scientific divisions of the department which are now occupying rented quarters. The bill has been placed on the calendar of the House, and will be called up some time next week.

THE House Committee on Appropriations has received an estimate from the Secretary of the Treasury of an appropriation of $15,000 for expenses of procuring and transporting to the National Zoological Park, Washington, D. C., specimens of the indigenous animals of Alaska, and of constructing the necessary paddocks and houses.

THE Council of the province of Brabant in Belgium has decided to establish an Institute of Bacteriology. About $30,000 will be spent on the building and about $9000 annually for maintenance.

A COLONIAL institute is to be opened in Marseilles to prepare young men to fill positions in the French colonies. Expeditions of students will be sent out at the expense of the State, and commercial houses will receive the information thus obtained in the form of detailed reports. Instruction will be given in botany, zoology, natural history, colonial geography and history, etc. There will be a museum of plants, minerals, etc., so that the student may become acquainted with the actual products of the colonies; also, a school of medicine to familiarize him with diseases peculiar to tropical countries. It is probable that arrangements will be made for teaching oriental languages. For grounds and building, the city of Marseilles has donated $193,000.

CONSUL-GENERAL GUENTHER, of Frankfort, writes to the Department of State that the negotiations between the city of Hamburg and the Imperial German Foreign Office for the establishment of a tropical hygienic institute at Hamburg have been completed. According to agreement, an institute for ship and tropical diseases is to be opened on October 1st. Its purpose is to investigate these diseases, to serve as a preparatory school for physicians to go to German colonies in tropical climates, and for the study of hygienic questions. The head physician and his scientific assistants will be selected at Hamburg with the consent of the colonial department of the Foreign Office. The general government will contribute to its support, while the city of Hamburg will have to furnish at all times as many beds as the colonial department may require. Dangerously contagious diseases, as pest, cholera, and smallpox, will not be treated in the institute. The Senate of Hamburg has submitted the project to the city for approval and has also recommended an appropriation of about $31,500 for remodeling the hospital for sailors.

THE London *Times* gives the following details in regards to the late Dr. William Marcet, whose death we were recently compelled to record. He was the eldest son of Professor Francis Marcet, of Geneva, and grandson of Dr. Alexander Marcet, of Guy's Hospital, and Jane Marcet, the authoress. He was born and educated in Geneva. At the age of 18 he commenced the study of medicine at the University of Edinburgh, where he was the champion and friend of Murchison, Burdon Sanderson, William Priestley, and others since distinguished in medicine and science. After graduating with honors, in 1850, Dr. Marcet came to London and devoted himself to the practice of his profession and to scientific work. For his researches in physiological chemistry he was elected a Fellow of the Royal Society at an early age. He was also one of the first workers in the field of laryngology. During his residence in London he held the offices of assistant physician to the Westminster Hospital and to the Brompton Hospital for Consumption. During the latter part of his life Dr. Marcet devoted himself almost entirely to scientific work. His ardent love of mountains and mountaineering to a large extent determined the direction of his later work. An inquiry into the influence of altitude on respiration, which he carried out with characteristic vigor and thoroughness both on the high Alps and on the peak of Teneriffe, led the way to an extended series of valuable observations and experiments on the phenomena of respiration in man. These formed the subjects of several important contributions to the Philosophical Transactions and inspired his Croonian lectures delivered before the College of Physicians in 1895. Dr. Marcet was also a well known worker in the field of meteorology and climatology and was the author of an excellent treatise on Southern and Swiss health resorts. He was elected President of the Royal Meteorological Society in 1888. In 1865 Dr. Marcet was requested by the members of the Royal Commission for the Investigation of the Cattle Plague to undertake to investigate the chemical pathology of the disease, and his report on the subject appeared as an appendix to the third report of this Commissioners. The late Sir Thomas Watson remarked of the report of this Commission "that probably no disease either of man or of animals has ever undergone such an investigation in all its details as has the cattle plague." In 1859 he was elected a Fellow of the Royal College of Physicians, appointed examiner in chemistry in 1867, and subsequently served the office of councillor.

The Council of the Royal Statistial Society, as we learn from the London *Times*, are sending out to various societies and councils a note on the Census Bill, drawn up by a sub-committee of the society, with a request that they will use their influence to induce Parliament to include in the Bill a provision for the taking of an intermediate census of a simple and comparatively inexpensive character in the year 1906, so as to afford to statisticians and others the benefits of a quinquennial numbering of the people. It is pointed out that, unless the Government can be induced to make provision for it at the present time, when the Bill for the decennial census is before Parliament, no opportunity will occur for another ten years. Regarding the Census Bill generally, the sub-committee in their note welcome the improvement in simplicity and arrangement of the provisions. They state that they made in all nine suggestions. Of these one has not yet been brought before Parliament another has been adopted in part only; six have found recognition; and one only has been ignored. The results are briefly as follows:—(1) Uniformity has been secured in two of the three kingdoms; (2) in Clause 1 the date recommended by the society has been adopted; (3) in Clause 4 (1) (*a*) the nationality of those born abroad is to be recorded; (4) in Clause 4 (3 and 4) the 'tenement' is substituted for the 'storey'; (5) in Clause 5 (1) the prescription that schedules are to be copied into books has been omitted, and in Clause 10 (1) (*c*) the matter is left to the registrars-general; (6) in Clause 5 (2) the record of houses occupied, though not inhabited by night, is ensured; and (7) the early introduction of the Bill this Session allows probably fair, though not abundant, time for preparations. The sub-committee, however, are greatly disappointed to note that the Bill contains no provision for an intermediate census of the simple character recommended not only by the Statistical Society, but by a very considerable weight of opinion in the medical, actuarial and municipal world. The Statistical Society has not recommended that the enumeration should be on each occasion in the full detail of a decennial census, which is the plan adopted abroad, but that the population by sex and age will suffice at the intermediate period. The project, though supported by the Departmental Committee of 1890, was rejected on the ground of expense, but this consideration carries less weight if it be held that the intermediate census is a necessary supplement to that of the decennial period, and that without it the latter loses a great part of its value after a few years. The simpler enumeration would cost less than half as much as a general census, and, for £50,000 or so, would maintain the continuity of observation to an extent to which all those interested attach the highest value.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of the late Sidney A. Kent, of Chicago, the University of Chicago receives $50,000 and the Chicago Art Institute the same sum.

MRS. ALICE M. RICE, of Worcester, Mass., has bequeathed $25,000 to Bowdoin College and $5000 to the Worcester Polytechnic Institute. The latter institution also receives a further contingent bequest of $5000 and one-half the residue of the estate.

THE Maryland Legislature has appropriated $24,000 a year for two years to the Johns Hopkins University. It will be remembered that for the past two years $50,000 has been given annually by the State to the University. The request for a continuation of the appropriation was bitterly opposed, but finally $25,000 was granted by the Senate. The House rejected the Senate Bill, as we reported last week, but it was finally brought up under the 'Omnibus' bill and passed, after being reduced to $24,000 a year.

ON April 6th the Physical Laboratory of Lehigh University was destroyed by fire. The building was 220 feet long, 44 feet wide, and four stories high. It was built in 1892 at a cost of $115,000 and it contained apparatus worth about $35,000, most of which was destroyed. The private Library of Professor W. S. Franklin was mostly saved. The trustees at a meeting on the same day decided to rebuild at once the Laboratory, which will be equipped and ready for occupancy by next September.

THE University of the South at Sewanee, Tenn., has received $50,000 from Mr. George W. Quintard of New York City.

MR. JOSEPH A. CORAN has given $20,000 to Bates College for a library building.

MR. GEORGE B. HARRISON, of Bloomington, Ill., has given to the Powell Museum, of Illinois Wesleyan University, a valuable collection of minerals, fossils, and specimens of natural history, which he has made during the past twenty-five years.

IT is understood that part of the recent gift of $200,000 made by Sir William MacDonald, of McGill University, will be used to secure an extensive mineralogical collection.

AN anonymous benefactor has undertaken to endow a Colonial Fellowship of £100 a year for five years in connection with the Liverpool School of Tropical Medicine. It will be granted to a graduate or student of a Colonial University who desires to carry on bacteriological work in the Thompson-Yates laboratories.

WE much regret to learn that the board of regents of West Virginia University, Morgantown, W. Va., has formally received from President Raymond charges of insubordination and incompetency against five of the professors with the recommendation that they be dismissed. The members of the faculty will file countercharges and will insist upon the removal of the president.

DR. FRANK R. LILLIE, professor of biology at Vassar College, has accepted a professorship in the zoological department of the University of Chicago.

PROFESSOR WILLIAM OSLER of the Johns Hopkins University states that he is not a candidate for the chair of medicine in the University of Edinburgh.

DR. EDWARD A. ALDERMAN, president of the University of North Carolina, has been elected president of Tulane University to succeed the late Col. William Preston Johnson.

MR. H. WOODS, of St. Johns College, Cambridge, has been appointed university lecturer in paleozoology.

DR. HERMANN JULIUS KOLBE, curator of the Zoological Museum of the University of Berlin, has been promoted to a professorship.

DR. HUGO HERGESELL, docent and director of the Meteorological Institute of the University at Strassburg, has been appointed associate professor.

DR. KÖNIGSBERGER has qualified as docent in physics in the University of Freiberg, i. B. and Dr. August Klages, in chemistry at the University of Heidelberg.

SCIENCE

FRIDAY, APRIL 20, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*THE ATOMIC THEORY FROM THE CHEMICAL STANDPOINT.**

THE Atomic Theory is the most fundamental hypothesis of the chemistry of to-day and plays a greater part in this than in any other science, and to give an account of all the classes of chemical phenomena which it is sought to explain by its aid would require far more time than I have at my disposal. I shall limit myself to giving as briefly as possible the main facts which have led chemists to adopt it and to stating which of the various properties which have been ascribed to the atoms are, and which are not, essential to its use in chemistry, and what properties may be attributed to them, solely on the basis of chemical experiments.

The question whether any given portion of matter is continuous, absolutely the same throughout, even if infinitely divided, or whether it consists of particles separated by comparatively empty space, is, of course, almost as old as philosophic thought. The beginnings of chemistry lie still further back; the first man who questioned why wood burns, or why grape juice turns to wine, was an incipient chemist.

About the middle of the seventeenth century, Robert Boyle, who originated our present conception of element and compound, applied the atomic theory to chemistry, in-

* Read before a joint meeting of the Chemical and Philosophical Societies of Washington, November 25, 1899.

terpreting chemical combination as a joining together of elementary corpuscles. Boyle's view had little influence on chemistry, and I think naturally. In the absence of more definite chemical knowledge than then existed, I should consider the conception that water and alcohol, for example, are perfectly continuous, and that their mixing is a perfect blending, quite as plausible as, and less contradictory to the evidence of the senses, than the view that they consist of discrete particles which mix, but do not penetrate each other. Up to the beginning of the present century those who adopted the atomic hypothesis did so from supposed physical or metaphysical necessity, rather than on the basis of any satisfactory chemical evidence.

The general acceptance of the atomic hypothesis by chemists was due to the experimental establishment of two laws, which are among the most fundamental principles of chemistry—the *Law of Constant or Definite Proportions*, and the *Law of Multiple Proportions*. For the benefit of those who have forgotten their chemistry I may state briefly in what these laws consist.

The Law of Constant Proportions.—Every chemical compound has an invariable composition, that is, the relative weights of the elements entering into it are invariable. On comparing the composition of numerous substances, it was soon found that to each element might be attributed a certain number, the *combining number*, which represents the proportion by weight in which that element enters into combination. If we compare, for instance, the compounds which the akali metals lithium, sodium and potassium form with the halogens chlorine, bromine and iodine, we find the following relations: 7 parts lithium unite with 35.4 parts chlorine; 80 parts bromine, or 127 parts iodine; similarly 23 parts sodium unite with 35.4 parts chlorine; 80 parts bromine, or 127 parts iodine, and so on.

Lithium.	Sodium.	Potassium.
7.	23.	39.
Chlorine.	Bromine.	Iodine.
35.4.	80.	127.

These figures, which merely express the results of analysis, are the combining numbers, and to each of the seventy-five or more elements belongs its own proper combining number.

The Law of Multiple Proportions.—Elements often combine in more than one proportion. When this is the case, the different weights of the one, which unite with a given weight of the other, bear a simple relation to each other. A good example of this is found in the chlorides of the metal molybdenum, of which four are known. The combining number of molybdenum is 96, and 96 grams molybdenum combine with respectively 2, 3, 4 and 5 times 35.4 grams chlorine, 35.4 being the combining number of the latter, the resulting compounds being represented by the formulas $MoCl_2$, $MoCl_3$, $MoCl_4$ and $MoCl_5$. A somewhat more complicated case is found in the paraffine series of hydrocarbons, CH_4, C_2H_6, C_3H_8, C_4H_{10}, C_5H_{12}, etc. Both laws apply as well when the compounds contain more than two elements.

These two laws hold without exception through the many thousands of known chemical compounds. They involve nothing hypothetical, being simply the expression of analytical results in a particular form. They were established mainly through the labors of Richter, Proust, Dalton and Berzelius, but to Dalton belongs the credit of having employed the atomic theory in explaining them.

If matter be absolutely continuous and capable of any degreee of subdivision, it is difficult to see why each element should have a definite combining number, which holds without exception, and why there should be distinct compounds well marked off from others, instead of different substances shading off into each other by infinitesimal differences. Why, for example, should there not exist a sodium chloride with 34 or 36 parts chlorine to 23 parts sodium, as well with 35.4 parts? It is true that we may bring these elements together in any proportion, but unless the ratio is just 23 to 35.4, the excess of the one or the other will be left unchanged, and we always obtain a chloride with 23 parts sodium and 35.4 parts chlorine. The hypothesis of continuity does not explain why, in the series of molybdenum chlorides just mentioned, the weights of chlorine combining with a given weight of molybdenum should be in the proportion 2, 3, 4, 5, without any or every intermediate figure. It is quite as difficult to explain on this view why the same combining number always adheres to the same element no matter into what combine it enters; the combining number of chlorine might be 35.4 with respect to sodium, and any other figure with regard to lithium or potassium.

If, however, we assume that a given portion of each of the elements, instead of being capable of any degree of subdivision whatever, consists of minute parts, or atoms, each of which, while it may or may not be further divisible, nevertheless always acts in chemical reactions as if it were not, that is, acts as a whole; and if we assume that in the same elementary substance, these particles have the same weight, but that the weight differs in the case of each element, then we have a state of affairs which would necessarily lead to the two laws I have described. The combining numbers would represent simply the relative weights of these chemically ultimate particles; a sodium atom weighing 23, would unite with a chlorine atom weighing 35.4, or a bromine atom weighing 80, while a bromine atom weighing 80, would combine with one of potassium weighing 39. So, also, an atom of molybdenum, weighing 96, would unite with 2, 3, 4 or 5 chlorine atoms, each weighing 35.4.

It will be observed that this hypothesis involves no assumption as to the cause or manner of the union of these chemical atoms. Whether they simply lie side by side, each retaining its individuality, or whether they interpenetrate, fuse or blend together, and for the time lose their individual existence. We shall see presently that there are reasons for adopting the former view.

The *atom*, in a chemical sense, may be defined as the smallest portion of an element which acts as an independent unit in chemical changes; the chemical *molecule* is the smallest portion of any substance, elementary or compound, which retains all the chemical properties of the substance in mass and which can move to an unlimited extent, independently of other portions. The molecules of compounds, therefore, consist of several atoms; the molecules of elements, there is good reason to believe, are frequently composed of several like atoms, while in other cases they consist of but one. Each kind of atom, therefore, has a specific mass, represented by the combining number, and specific chemical qualities, by virtue of which the elements differ, as iron and sulphur. Of the relation of these little is known, except that the chemical qualities are to some extent periodic functions of the mass. It cannot be asserted that every atom has combining power, for a whole group of elements, the helium-argon group, shows no well-established tendency to form compounds.

Before proceeding to discuss the further properties which chemists have been led to attribute to the atoms, we may consider certain qualities which have from time to time been ascribed to them, but on which chemistry is silent. Speculators have often erred in attempting to elaborate their hypotheses too fully, and by making assumptions which have afterwards proved to be improbable or untenable, have brought discredit on views, which in their essentials, were of great value. Perhaps no hypothesis has suffered more in this respect than the atomic theory. In his book on the 'Concepts of Modern Physics' (p. 85), Stallo mentions certain points on which, he says, all atomists are agreed. Among others are these: "*Atoms are absolutely simple, unchangeable, indestructible; they are physically, if not mathematically, indivisible.*"

Without speaking for the physicists, I can assert most positively that none of these attributes are in the least essential to the conception of the chemical atom. Whether the atoms be *simple* or *complex*, *divisible* or *indivisible*, we have at present no satisfactory means of deciding, and whether they be one or the other, it in no wise affects the conception of the atom as the chemical unit. It is believed by some, on spectroscopic evidence, that atoms are decomposed at the high temperatures existing in certain stars, and a similar explanation has been offered for certain electrical phenomena exhibited by gases. All we can say at present is, that by no chemical or physical process known to us, do atoms undergo division or transformation to an extent appreciable by chemical methods. An atom of carbon always acts with the combining weight 12; if it consist of several independent parts, we do not know it, because in all reactions thus far known, these parts always act together. The idea of the transmutation of the elements, while resting at present on a very slender basis, is entirely justifiable as a working hypothesis.

The supposed *indestructibility* of the atom amounts merely to this, that with our limited range of experimental methods, we have not been able to cause any appreciable portion of matter to disappear as such permanently, but can always recover it unchanged in mass and chemical properties. To assert that matter cannot, under any circumstances, be made to disappear as matter, seems to me to be the most unjustifiable dogma imaginable.

As to the *unchangeableness* of the atoms, we are equally in the dark. That an atom of oxygen in water is similar in every respect to one in iron rust, we cannot assert. There are certain physical properties of the elements which persist in their compounds, among which are the optical properties. Every transparent compound has a definite molecular refractive power, and it has been found that the figure representing this may be divided up in such a way as to assign a definite portion to each atom in the molecule. If we once know the atomic refractive powers of the several elements, we can calculate with considerable accuracy the molecular refraction of any compound containing these elements. For example, the molecular refraction of alcohol, C_2H_6O, is the sum of twice the atomic refraction of carbon, six times that of hydrogen and once that of oxygen. Now remarkably there are certain exceptions. For instance, oxygen combines in either of two ways, which are called single and double union, which are symbolically represented in the case of carbon compounds, by $C = O$ and $C - O$. Its atomic refraction is different in these two forms, and we cannot positively state that the difference is not due to a temporary change of some kind in the atom itself. At the same time (with the above qualifications and some others of a similar nature) the persistence of the atomic refraction and certain other physical properties through all the combinations of an atom, affords some indication that its nature remains essentially unchanged.

Finally, questions as to the shape, size, hardness or penetrability of the atoms, are matters of indifference to the chemist at present. For his purposes they may be regarded simply as centers through which energy manifests itself, of like properties in the same element, but differing in mass and certain other respects in the different elements.

We may now consider some of the properties which the chemist does ascribe to the atom in addition to mass and specific chemical nature.

In recent years much has been learned about *chemical affinity*, a great part of which is susceptible of mathematical expression, and is independent of the atomic theory, only the experimentally determined combining numbers coming into consideration, the *gram atom* and *gram molecule* taking the place of the atom and molecule. As to the real cause or nature of affinity we are still totally in the dark. Very elaborate researches, however, have brought to light certain important facts to which I may properly refer, as they are at present incapable of interpretation apart from the hypothesis of atoms.

Each unit of an element is capable of uniting with but a limited number of other units, which differs in different cases. This may be illustrated by the hydrogen compounds

$$ClH, \quad OH_2, \quad NH_3, \quad CH_4.$$

The carbon atom can hold four hydrogen atoms, the nitrogen atom but three, the oxygen atom but two, and the chlorine atom but one. The combining power of carbon, nitrogen and oxygen atoms may be regarded as divisible into four, three and two parts respectively (with regard to hydrogen), while that of the chlorine atom is indivisible. The number of parts into which the combining power is thus divisible is termed the *valency* of the element, and each of these parts is termed a *valence, bond*, or *affinity unit.* Without going further into detail (for the subject is an elaborate one), it may be stated as a general law, that combination takes place by a valence of one atom acting on a valence of another atom, or by the several valences of one, acting on the corresponding number of valences of another atom or atoms. This is conveniently represented by lines joining the atomic symbols. Thus CH_4 and H_2O may be represented by the formulas

$$\begin{array}{ccccc} & & H & & \\ & & | & & \\ H & - & C & - & H, \\ & & | & & \\ & & H & & \end{array} \quad \text{and} \quad H - O - H$$

as the oxygen atom has two valences, these may combine each with a valence of carbon, thus

$$O = C = O.$$

This law holds invariably in the case of carbon compounds, and in general, but whether combination takes place only in this way in all classes of compounds is as yet an open question. The number of valences has nothing to do with the strength of affinity; a pentavalent atom has not five times the affinity of a univalent atom.

It was long ago discovered that there could exist several substances of the same percentage composition and molecular weight, but differing in chemical and physical properties, the so-called *isomeric* compounds. Sometimes as many as twenty distinct compounds of the same composition are known. This difference is inconceivable if the atoms are indiscriminately arranged, like a lot of different colored balls thrown together at random; there must be in each a definite arrangement of the atoms which cannot be changed without changing the nature of the compound. A comprehensive study of compounds, aided by the conception of valency, has led to the idea of the linkage of atoms in the molecule and to the so-called structural or constitutional formulas. The structural formulas of the two forms of butane, C_4H_{10}, are given, as illustrating the linkage of atoms, as well as the nature of isomerism.

$$CH_3—CH_2—CH_2—CH_3, \quad CH_3—CH<^{CH_3}_{CH_3}.$$

Such formulas are not intended to represent the actual form of the molecule; they are schematic merely; they are not fanciful, but are based on innumerable experiments, which do not concern us here. The innumerable facts of organic chemistry tally so well with the assumption of chemical units or atoms, linked together in definite ways, as to give to the hypothesis a very great degree of probability.

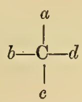
Some atoms can manifest a different valency according to circumstances; thus iron forms two chlorides, $FeCl_2$ and $FeCl_3$, in the former of which the iron atom is believed, for good reasons, to have but two valences (Fe''), and in the latter three (Fe''').

Of the cause of valency we know nothing, and in addition to what I have said we know but little, except that there is an intimate relation between the valences and the power of carrying electric charges, and that (in some cases at least) there is a definite geometrical relation between the valences.

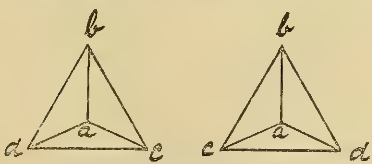
If a salt, for example, sodium chloride, be dissolved in water, and an electric current be passed through the solution, the sodium atoms move to the negative pole, carrying charges of positive electricity, and the chlorine atoms to the positive pole, carrying negative electricity. These electrically charged atoms (or groups of atoms) are termed *ions*. If the chlorides of iron be similarly treated, a similar result follows, the iron transporting positive electricity. There is this difference, however, that the divalent iron atom in $FeCl_2$ transports but two units of electricity, while the trivalent atom in $FeCl_3$ carries three. More complex molecules are frequently broken up into a mixture of simple and complex ions, the latter carrying a unit of electricity for each free valence, thus K_2SO_4 gives two positive K ions and the negative ion $= SO_4$, which carries two units; with regard to the amount of electricity carried the valences are therefore equivalent. What the cause of the relation between valency and electrical phenomena is, we do not know.

There is still another property of valency which has been discovered in recent years, and which is of the highest importance. It may be asked whether in the case of the carbon atom, for example, the division of the attractive power into four valences implies action in four distinct and fixed directions, that is, whether the atom possesses a sort of polarity, or whether the action may be in any direction. Thanks to the recent labors of organic chemists, it now seems tolerably certain that the carbon atom tends to exert its attraction in four distinct and tolerably fixed directions, rather than in all directions equally.

It has long been known that there exist certain pairs of organic compounds which have identical composition and molecular weight, which show identical chemical behavior and which agree in all physical properties except two. These bodies cannot be regarded as isomeric in the ordinary sense, as their structural formulas as usually written, are identical. The two respects in which they differ are these: in solution one rotates the plane of polarization of light to the right, the other to the left; when crystallized, they frequently show hemihedral faces, differing only in this, that the crystals of the one cannot be brought to coincide with those of the other, but are as an unsymmetrical body and its reflected image in a mirror. I have said that the ordinary structural formulas are schematic merely, they do not claim to show the actual relation of the atoms in space. Two molecules, whose geometrical forms are identical except in being right- and left-handed or as object and reflection, would be represented by the same structural formula, and would have the same chemical, and in general the same physical properties; their action on polarized light, however, would be the same, but in opposite directions, and their crystalline form, if unsymmetrical, would be so in opposite senses. In short, the isomerism would not be chemical, but *physical* or *geometrical*, like the pairs in question. It was further observed that in every case of this kind the molecule contains an 'asymmetric carbon atom,' a carbon atom united with four atoms or groups each differing from the others:



If we regard the groups *a*, *b*, *c*, *d* as interchangeable in position, or as rotating independently about the central carbon atom, we cannot explain the apparent right- and left-handedness of the molecule; there could be no fixed difference between the two compounds. If, however, as van't Hoff and Le Bel pointed out, we suppose the four valences to extend in the directions of the apices of a tetrahedron and to be fixed in these directions; then when the combined groups are all different, we obtain two forms of molecule which are identical in every respect except that the one is like the reflected image of the other.



The figures represent two tetrahedra the centers of which are supposed to be occupied by a carbon atom, the four groups *a*, *b*, *c*, *d* being located in the direction of the apices. It is easily seen that the one corresponds to the reflection of the other in a mirror. It is to be distinctly understood that it is intended to represent only the direction of the valences, not the shape of the carbon atom. As, in general, these geometrical isomers are not readily transformed into each other, it follows that the combined groups or atoms have a strong tendency to retain their relative positions; in short, that the direction of the valences is practically fixed. The same holds true in the case of pairs of compounds in which there are two doubly united carbon atoms as

$$\begin{matrix} a \\ b \end{matrix}\!> C = C <\!\begin{matrix} c \\ d \end{matrix} \quad \text{and} \quad \begin{matrix} a \\ b \end{matrix}\!> C = C <\!\begin{matrix} d \\ c \end{matrix}$$

a simple rotation of one half the molecule about its axis, or an interchange of position on the part of *a* and *b* or *c* and *d* in one of these forms would convert it into the other, yet in reality this does not occur, and in general, the two forms represent distinct compounds. The theory has been applied with great success in predicting new compounds and in explaining the nature of substances containing several asymmetric carbon atoms in the same molecule, notably the sugar group. It does not imply that the molecule is rigid, but merely that there are certain fixed directions of attraction, about which, within limits, the combined atoms may vibrate. The concordance of a very great number of facts with this hypothesis, and the absence of any noteworthy exceptions, lend to it a high degree of plausibility. Whether the fixed direction of the valences is true of other atoms than those of carbon, is as yet uncertain. Carbon compounds lend themselves with especial ease to such studies, and the valency of carbon is practically fixed at four. The effect of varying valency, as in the case of iron, is unknown, but in the case of nitrogen, and to some extent in that of certain metals, some evidence has been accumulated, tending to show that the rule is a general one.

It will be seen that the theory of the

structural formula involves an extension of the older atomic hypothesis, in that it asserts definitely that the combining atoms do not blend, but come into juxtaposition in some orderly and systematic fashion, while stereochemistry, or chemistry in space, asserts that the parts of these systems are to a certain extent fixed in relative position, not rotating about each other after the manner of the members of the solar system. As to the inner nature of the atom itself, however, it says absolutely nothing.

To sum up, the laws of Constant and Multiple Proportions have led the chemist to regard matter as not continuous, but composed of units or atoms, these having the same mass and specific chemical properties in the same element, but other masses and other chemical properties in other elements. Innumerable facts lead him to believe that the atoms in the molecule are not blended, nor so juxtaposed as to have an arbitrary and constantly varying relation, but combined in such a manner that there is a more intimate relation between some atoms than others, some forming connecting links between the rest, a relation which is schematically represented by structural formulas. Finally, stereochemical phenomena indicate that the molecule possesses a certain definite geometrical structure, not necessarily rigid, but not having a mobility of its parts analogous to that of the parts of the solar system. As to the further divisibility of the atoms, their unalterableness, indestructibility, form, origin, and, in short, their absolute nature, the chemist knows nothing and has no opinion of real weight—for him they are merely centers through which energy manifests itself.

If those who adopt the atomic theory would carefully distinguish between essentials and non-essentials, and if those who deny the possibility of interpreting vital phenomena in terms of physics and chemistry would bear in mind that we know scarcely more of the inner nature of the fragment of carbon than of the protoplasm into whose composition it enters, and that affinity is after all is as great a mystery as consciousness, we might possibly hear less of the impossibility of gross, inert, dead matter containing within itself "the promise and potency of every form and quality of life."

H. N. Stokes.

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*SOME OBJECTIONS TO THE ATOMIC THEORY.**

For the purpose of this discussion, all metaphysical conceptions or discussions are ruled out, and it is explicitly confined to that definition of the atom or molecule connoted by Dalton's famous hypothesis with such amplifications or modifications as have been brought about by the subsequent advance of physical science. In its inception the hypothesis was not without objectors, and properly so.

The efforts of Wallaston and others to insist upon the importance of considering 'combining numbers' or 'reacting masses,' things which one could really know about and determine experimentally, rather than hypothetical atoms, the existence of which in the nature of things was beyond physical proof, was philosophically sound, as far as it went. But the historical vicissitudes of the hypothesis, interesting though they be, can not be considered here, but rather, attention must be given to the comparatively recent discussions on this subject as they have appeared in contemporaneous epistemological writings.

The attempt will be made to present the present status of the subject with due regard to relative perspective values, rather than to cite article and authority in an historical retrospect. Dalton's hypothesis

* Paper read before the joint meeeting of the Chemical and Philosophical Societies of Washington. Time allotted for this contribution to the program, 15 minutes.

according to the generally accepted view of its genesis, was the result of an attempt to provide a mechanical explanation for the solution of a gas by a liquid. Under the influence of some force the particles of the gas are impelled, or diffuse among the particles of the liquid. The same is true of all solutions, the substance going into the solution disappearing as such. And furthermore, the solution, when in equilibrium, is homogeneous; consequently the particles must be very small though they remain discrete, and they must be uniform in mass, volume, and other properties.

The selection of the historical name atom for the particle did not necessarily imply anything more than has just been given. The apparently ready explanation these views gave for the laws of definite and multiple proportions which Dalton had already advanced, undoubtedly had a preponderating influence in bringing about their general acceptance. It is easy to see that granting the atomic hypothesis, the combination of two substances to form another, always identical, must be in definite proportions, or number of atoms or when there are multiple proportions they should bear a simple ratio to one another. But it is not easy to see how the atomic constitution of matter follows, as a necessary, if sufficient condition, from the laws of chemical combination, looked at purely objectively.

It would seem as though the human mind was so constituted that it necessarily demanded a mechanical explanation of recognizable phenomena. Indeed, some of our foremost thinkers apparently insist upon the truth of this proposition, and to Lord Kelvin, if memory serve me correctly, is credited the remark that he finds it impossible to understand phenomena for which he cannot construct a mechanical model, meaning mentally, of course.

It is natural that this feeling should exist. Our earliest impressions are associated with mechanical phenomena. These phenomena are intimately connected with our visual and tactual impressions, with just those senses, normally most cultivated, and most closely associated with the logical faculty. All through life a very large proportion of every day experience is with mechanical processes. We thus come to look for the 'mechanism' of all phenomena of which we become conscious, and when it is not obvious we supply it by analogies from better known phenomena; thus the tendency to reduce all phenomena to the lowest terms of matter and the three laws of motion. This leads to the consideration of the Herbartian School, which is hardly within the scope of this paper. The point to be made is that the conception of the atomic constitution of matter to explain the laws of chemical combination is not in itself susceptible of proof, nor in the nature of things is it probable that it ever will be; and that after all, as we have it to-day, it is nothing more nor less than an *analogy* with a conceivable mechanical process. This idea has been more or less clearly brought out sometime since by J. J. Thomson, Mach and others. It has been treated, though not perhaps specifically, by Ostwald, in his now famous paper on the 'Failure of Scientific Materialism,' wherein he very clearly indicates the ultimate weakness of mechanical explanations of phenomena where they long held sway, instancing the *ignorabimus* polemics resulting from the famous address of Du Bois-Raymond; and more familiar perhaps the development of the theory of light, from the corpuscular theory, through the undulatory theory with its hypothetical ether, demonstrated by Kelvin to be necessarily unstable and physically non-existent, to the recent electromagnetic theory; and cites Hertz with whose name this theory is so closely associated as declaring that he saw nothing in it but six differential equations, in an effort to save it from the inherent weakness of a possible mechanical explanation. A further instance of the failure of mechanical conceptions to account for observed phenomena is cited in the attempt of Helmholtz, Clausius, Kelvin, not to mention less well known workers, to modify Mayer's conception of the equivalency of various forms of energy, by the notion that all forms of energy are fundamentally the same—mechanical energy. Whereas it has remained impossible to conceive of a working mechanism for certain forms of energy, this idea is no longer urged as an appendage to the original conception, though it is pointed out its freedom from any arbitrary hypothesis should have been a sufficient reason. In another place he calls attention to the arbitrary hypothesis in the kinetic theory of gases ; of artificially neutralizing the properties of directions by assuming that collisions are taking place equally in all directions; and the consequent failure, when attempts are made to extend the theory to electrical energy for example. This has been clearly pointed out by Mach also.

What we know of the outside world is through our senses, inherently energy manifestations. Of what gave rise to the sensations we know naught but these energy phenomena, or differences of energy. We are not accustomed to regard them objectively however, and we conceive for ourselves a mental picture, a mechanical one, *matter*, which it is true we cannot attempt to disassociate from energy, as giving rise to the energy manifestations which we can and do know. And to this hypothetical matter are ascribed properties, the most striking being its permanency or 'indestructibility.' Says Mach, "all our effort to mirror the world in thought would be futile if we found nothing permanent in the varied changes of things. It is this that impels us to form the notion of substance."

The hypothetical existence of matter is then merely a mental effort to give a mechanical explanation to observed energy phenomena; not as will be presently indicated that it is necessary we should have a mechanical explanation of phenomena, but that it has become a habit of mind with us. And with the notion of matter and of matter as made up of discreet molecules or atoms, we bring in many other arbitrary hypotheses. In accounting for special phenomena we have modified our original hypotheses with special attributes to meet each specific case : the present notions regarding the asymmetric carbon atoms; space isomers and polymers in general; varying valency; complex or 'physical' molecules determining the symmetry of crystals, etc. It is not contended by any one that these hypotheses have not been useful. Indeed, in the field of organic chemistry it is not easy to see how it could have reached its present highly developed stage without them. But it is contended that with a realization of the exact position of the hypothesis with relation to the phenomena for which it seeks to account, should come a realization of the retarding influence it undoubtedly has had, and may have on the development of science. It has been well said, that "it would not become physical science to see in its self-created, changeable, economical tools, molecules and atoms, realities behind phenomena. Forgetful of the lately acquired sapience of her older sister, philosophy, in substituting a mechanical mythology for the old animistic or metaphysical scheme, and thus creating no end of supposititious problems. The atom must remain a tool for representing phenomena like the functions of mathematics."

But if it be philosophically weak to use this mechanical device in accounting for observed phenomena, because unnecessary, because it necessitates a constant modification by subsidiary hypotheses and finally shows evident signs of being ultimately as futile as mechanical explanations in general have proved for all classes of phenomena the question immediately arises, why not abandon it? Especially when we are already in possession of so elegant and flexible a method for the statement of phenomena as is furnished by the language of mathematics.—An instrument so highly developed, so fertile in suggesting interrelations, by its facility in bridging long mental processes as often to create an uncanny feeling to which the great Euler gave expression, that "his science in the person of his pencil surpassed himself in intelligence."

Should we not rather agree with Mach who has defined physics (including of course all physical science) as "experience arranged in economical order," that the "aim of research is the discovery of the equations which subsist between the elements of phenomena."

This I take it may be regarded as a fair presentation of the 'phenomenology' or, 'mathematico-physico-phenomenology' point of view in contradistinction to that of 'atomistics.' Of the many contributions to the discussion, direct or indirect which contemporaneous literature furnishes, perhaps the most notable is from Boltzmann. He insists that both methods of presenting phenomena are but *methods;* that each possesses inherent advantages, that neither can with fairness be dogmatically declared superior, and until it shall have come about that the one has absorbed the other, both methods should be developed together. By both methods it is possible to present *comprehensive* conceptions of fields of phenomena not possible to direct description. But we should guard against introducing any unnecessary arbitrariness, rather than follow Ostwald in attempting no concept at all. That as a matter of fact, the concepts of the calculus rest fundamentally on the notion of a finite number of elements; otherwise the theory of limits has no meaning and the differential equation does not represent a possibility. This is of course an essentially atomistic conception.

In avoiding arbitrariness as far as possible, by assigning as few properties as may be necessary to the atoms in any particular field of phenomena, we obtain special hypotheses.

Phenomenology attempts to co-ordinate these special hypotheses in one concept. There are at least two difficulties; the corresponding differential equations differ, making their comparisons a very complicated matter; they relate to stationary or nearly stationary conditions and cannot fairly represent turbulent reactions. The 'energetic phenomenology' attempts to consider what is common to these various fields, such as the energy laws, but fails because its results are too general, and the analogies are not applicable in all details.

Atomistics would attempt to co-ordinate these fields, by modifying the assigned properties of the atoms, and thus obtain a simultaneous, comprehensive view of the whole, to an extent not approached by phenomenology. Further, by this method some notion is to be had of turbulent actions. But the assigned properties of the atoms must be in accord with the special concept of the phenomenology, and therefore this latter should be developed also. So that atomistics, though they have hindered progress at times, still have a use. And the danger is in confusing the phenomenology of results alraedy established with the atomistic hypotheses which sever to hold them together.

Volkmann suggests a further qualification to these views to which Boltzmann assents, dividing physical phenomena into three classes: Coarser phenomena as elasticity or capillarity, where atomistic hypotheses are unnecessary; finer phenomena as electrolyses, dispersion of light, etc., when atomistics may be useful; and a middle field when the usefulness of atomistics is doubtful, and to this last field only does Boltzmann's contention apply that both methods should be developed together.

Whether or no we may agree with Boltzmann as to the atomistic basis of the calculus, or the propriety of Volkmann's classification, we shall be inclined to hold his main contention as sound and conservative, albeit on utilitarian grounds. Both the language of mathematics, the medium of expression of the phenomenologist, and that of the atomisticist are but methods, after all, human instruments, ingeniously devised and beautifully developed, but merely instruments.

Whether we shall obtain a theory for observed phenomena which shall be as comprehensive as the atomic hypotheses without its adherent drawbacks, as flexible, as labor saving, as suggestive as the calculus, without its complexity in certain desired applications, by the absorption of one method by the other, it is not possible to say as yet. Quite possibly the ideal theory is to come from an entirely different direction. But for the present we must use those instruments which are at hand, and as long as they prove useful each in itself is worth the highest development we can give it. The idea expressed by one of the previous speakers this evening, that the coming generation will shake off the fetters of 'mechanism' and concern itself with 'parameters' may be true, but it seems to me a rather bold prophecy. More likely is it that notions of the 'atoms' and 'parameters' will develop side by side, the distinguishing feature of their study being a clearer view, a *realizing sense* of their exact relationship to phenomena. And with this it seems fair to assume will come those new principles which Ostwald has prophesied to account for phenomena, where the 'energistics' has failed and whose form it is futile to predicate at present.

To this end the discussion was probably necessary and should prove most useful. It is to be regretted that the time allotted me will not suffice to call to your attention the views of other thinkers on this most interesting subject. I trust that what I have been able to bring before you will at least indicate the status and importance of the subject.

FRANK K. CAMERON.

ON ARTIFICIAL PARTHENOGENESIS IN SEA URCHINS.

IN the last October number of the *American Journal of Physiology* I published a preliminary note on the artificial production of larvæ from the unfertilized eggs of the sea urchin. I mentioned that unfertilized eggs were able to develop into normal plutei after having been in a solution of equal parts of a 20/8 n $MgCl_2$ solution and sea water for about two hours. The control experiments by which the possibility of a fertilization of these eggs through spermatozoa had been excluded were briefly mentioned. In the April number of the same journal a full description of my experiments was published which I believe puts an end to any doubt concerning the possibility of an error. Nevertheless I decided to repeat these same experiments with the additional precaution of using *sterilized* sea water. Through the kindness of the board of trustees of the Elizabeth Thompson Fund I was enabled to make further experiments on artificial parthenogenesis at the Pacific Coast. These experiments have led to a number of new results which will be published in the *American Journal of Physiology*. Here I will confine myself to a description of the precautions which were taken in these experiments to exclude the possibility of a fertilization of the eggs through spermatozoa.

The sea water used for these experiments was heated the day before, very slowly, to a temperature of from 50 to 70° C. and was kept at that temperature for about ten minutes and allowed to cool very slowly. The control experiments proved that, as was to be expected, the spermatozoa are killed by this treatment. During the time the water was heated no sea urchin was opened in the laboratory or was even kept there. The sterilized sea water was kept in special flasks and covered jars which were utilized for this purpose only. Before we started an experiment we disinfected our hands thoroughly with soap and brush in the same way as is customary in a surgical operation. Every sea urchin before it was opened was exposed for from two to five minutes to a powerful stream of fresh water and care was taken to wash the whole surface of the animal as thoroughly as possible with fresh water. The mouth of the sea urchin was then cut out with scissors that had been sterilized the day before in the flame and had been kept dry since. Through the excision of the mouth the sexual glands were exposed and their color allowed to decide whether the animal was a male or a female. If the first animal that was opened was a female the intestine was removed with a sterilized forceps and care was taken not to bring the forceps in contact with the ovaries or with the outside surface of the animal. After the intestine had been removed and nothing left except the ovaries, the inside of the animal was repeatedly filled with fresh water and washed out. Then each of the five ovaries were taken out *in toto* with a sterilized section lifter and special pains were taken that the ovaries did not come in contact with the surface of the sea urchin or with the hands of the experimenter. The ovaries were first put into a dish of fresh water, were washed off carefully and then put into sterilized sea water.

One part of the eggs was put into sterilized sea water to serve as control material. A second portion was put into a mixture of equal parts of sterilized sea water and a 20/8 n $MgCl_2$ solution. An hour or two later these eggs were taken out of this mixture and put into sterilized sea water. While of the latter eggs as many as 25 per cent. developed into blastulæ and swam around the next day, not an egg of the control material even segmented. We spent hours searching the control material for segmented eggs but were never able to find a single one.

In addition to these control experiments we made several others. It was necessary to apply the mixture of equal parts of the 20/8 n $MgCl_2$ solution and sea water for from one to two hours in order to bring about the development of the unfertilized eggs. We made it a rule to take out one portion of eggs from this solution much earlier—in some cases after ten minutes. In no case did one of these eggs segment or develop.

A third series of control experiments was applied. Solutions with less $MgCl_2$ and more sea water were tried. In solutions of 30 cc. 20/8 n $MgCl_2$ and 70 cc. sea water not an egg was able to develop.

If the first animal opened in these experiments happened to be a male the instruments were at once laid aside for disinfection and the next animal was opened by another experimenter with the same precautions.

In some experiments we used sea water that had been filtered through a new Pasteur filter. Although no spermatozoa are able to pass through such a filter, the eggs treated with a mixture of equal parts of a 20/8 n $MgCl_2$ solution and filtered sea water developed while none of the control eggs were able to develop.

In one of the former papers I mentioned the fact that the mixture used for artificial fertilization killed the spermatozoa in a comparatively short time and injured many of the eggs. Contrary to the common prejudice, it is a fact that spermatozoa are much more sensitive and are killed much sooner than the egg.

My experiments at Pacific Grove were carried on with *Strongylocentrotus franciscanus* and *purpuratus*. In both animals artificial parthenogenesis can easily be accomplished.

In the experiments at Pacific Grove I enjoyed the valuable assistance of Mr. W. E. Garrey.

JACQUES LOEB.

THE UNIVERSITY OF CHICAGO.
April 3, 1900.

A CURIOUS PHASE OF INTER-STREAM EROSION IN SOUTHERN OREGON.

THE 'Rogue River Valley,' in southwestern Oregon, is one of the five great depressed areas of the Pacific Coast country, which separate the Klamath and Coast ranges from the Sierra Nevada and Cascade Mountain systems. Its main stream, the Rogue River, issues from deep cañons in the Cascade Range, and flows thence, in its middle course, through a broad valley whose floor is a flat plain, two to five or more miles in width. In crossing the basin, the stream found soft strata to work upon, and not being obliged to cut deep, it eroded a broad valley, strongly contrasting with the cañons above and the narrow, rocky gorge in which the river makes its passage through the Klamath Mountains near the sea. All the tributary streams within the area of the basin have eroded similarly broad, flat-bottomed valleys, and between them they have reduced to a local base-level, the greater portion of an area forty or fifty miles in length by twenty to thirty miles in width. Within these limits there are many hills and low mountains, remnants of the Tertiary strata in which the broad valleys are excavated, but they are quite insignificant in comparison with the high mountains which enclose the basin, of which the Siskiyou range on the southwest rises to 7000 feet and over, and the Cascades on the east to 6000 feet on the average, surmounted by the beautiful volcanic, snow-clad cone of Mt. Pitt.

Since the partial base-leveling of the 'Rogue River Valley,' which doubtless was accomplished nearly at sea-level, the territory has been elevated and the basin tilted, mainly toward the northwest. The valley plain descends from an altitude of about 1900 feet at Ashland to less than 1300 feet where the C. & O. R. R. approaches the Rogue River. In ascending along the river, the gradual rise in the plain is everywhere quite perceptible, and it has attained an altitude of approximately 2000 feet where the main stream issues from the foot-hills proper of the Cascade Mountains. This tilting has increased the gradient of the streams, causing them to cut below the old level, and all the principal ones now flow in comparatively narrow, sharp-cut, cañon-shaped troughs, excavated from 30 to 75 feet below the valley plain. These cañons are few and widely separated, telling of the youthfulness of this new cycle of erosion.

The inter-stream tracts are broad plains, undissected by deep gulleys. Some portions of them are without timber or even chaparral, although generally supplied with a sparse growth of grass, and in the vernacular of the country are known as deserts. It is on these 'deserts,' some of which are four or five miles in length and one to three miles in width, that is developed the peculiar type of surface erosion which has given rise to this paper.

When viewed from a distance, the surface of the 'deserts' appears to be remarkably even, suggesting an absolutely uneroded, water-laid deposit such as might result from the complete filling of a broad, shallow lake basin. But, upon endeavoring to cross these barren plains in the rainy season, the traveler is unpleasantly made acquainted with the fact that the whole surface is cut up by a system of shallow gulleys or gutters, in which water commonly stands, but there is rarely observed a flowing stream. This system of gulleys is not of the familiar dendritic type of other regions. The gutters are all connected, but branch and inter-branch in a very confusing manner. There seem to be no trunk streams (properly so called) and tributaries. In fact, there is a perfect net-work or labyrinth of gutters carved into the surface of the plain, completely surrounding and isolating low, gently rounded mounds of gravelly material from 30 to 150 feet in diameter, and whose tips represent the original plain surface of the valley floor, and give these 'deserts' their apparent evenness as seen from a distance.

The gutters are from 3 to 30 feet in width, and are constantly narrowing and widening from no cause which has yet appeared. Sometimes they head in a small rounded basin, 30 to 50 feet in diameter. Indeed, it may be said that the whole system is made up of rounded, elongated basins, connected by narrower channels. *Yet whatever may be the width, all portions of these gulleys are trenched to about the same depth beneath the original surface, namely, about 3 feet.* The little basins at the heads are as deep as the gulleys on the borders of the 'deserts' where they are about to enter the cañon valleys of the main streams. They are floored with rounded, waterworn cobbles of black volcanic rock, of comparatively uniform size, and never seem to contain any ordinary stream deposits such as gravel or sand.

The settlers of the region commonly refer to these depressions, containing standing water during the rainy season, as 'pot-holes,' but it is obvious that they do not represent the typical remolinos or pot-holes of stream-bed erosion. I have the following explanation to offer: The surface formation of these 'desert' tracts is a bed of obscurely stratified, water-laid gravel and sand, containing a scattering of waterworn cobbles. The material has come largely out of the Cascade Mountains, as is indicated by the large numbers of fragments of chalcedony, agate and opal scattered over the 'deserts.' It was spread far and wide across the valley floor by the Rogue river and tributaries, perhaps during a short period of slight depression, and probably is the equivalent in taxonomic position of the Red Bluff gravels of the Sacramento Valley (of about the age, it seems to me, of the Illinoian drift-sheet of the Mississippi Basin). The cañon valleys have been carved since, trenching this gravel formation and cutting into the harder Tertiary rocks below. They reveal to us the fact that the gravel is only a thin layer, usually not much exceeding three or four feet in thickness, spread over the beveled edges of the older formations, which were base-leveled to form the general even floor of the valley.

During ordinary seasons, the erosion of the gulleys proceeds very slowly or not at all, but I learn from the inhabitants that at certain times, not often occurring, after very heavy rain storms, there is a decided movement of the water in the gutters, and at such times, the finer material of the gravel formation may be removed and carried into the cañons, while the cobbles remain behind to encumber the flat floors of the depressions. This erosive action is only active as far down as the base of the gravel, where the much harder volcanic rock is encountered, and this may account for the remarkably uniform depth of the gulleys. Their varying width and the labyrinthine character of the system may be due to some structural feature of the gravel formation, not appearing upon a casual examination.

Oscar H. Hershey.

Bragdon, Calif.,
Feb. 5, 1900.

THE SIXTY-SEVENTH ANNUAL REPORT OF THE COAST AND GEODETIC SURVEY.

The Report of the Superintendent of the Coast and Geodetic Survey for the year ending June 30, 1898, has just made its appearance from the Government Printing Office, in Washington. The publication has been somewhat delayed on account of numerous changes, both in form and matter.

A striking feature of the new report is the absence of large folded maps in the body of the work. The plan has been generally adopted of showing, by cuts, only such work as has been accomplished during the year, and to this end, all large illustrations are reduced to single or double page plates. Where clearness is equally served, small cuts are run in the text, thus very much adding to facility of description, as well as making the volume more convenient and economical. Two large progress maps are placed in a pocket at the end.

The type is of a pleasing character, known as French Old Style, and gives the page a clean open appearance. A departure has been made from the usual custom, in the matter of binding and margin. The type page is somewhat smaller, while no change has been made in the size of the leaf. The sombre black of the cover has been replaced by a grateful olive tint; the Coast and Geodetic Survey seal appears on the back, and the flag, a newly acquired insignia, ornaments the front. Withal, the book is not so large as the average one for previous years, owing partly to the elimination, already noticed, of the large unwieldy folded maps, and partly because of the omission of some matter hitherto published but now regarded as unessential in a general statement of the activity of the Bureau.

The whole subject is treated under four heads, viz:

I. The Survey and its Progress.
II. The Scientific and Technical Results.
III. The Administration.
IV. The Appendices.

Under the first head is an introduction, in which the appropriations are stated, and a general summary of the work of the year is given. This outlines the course of the work, and treats of the re-survey of Chesapeake Bay and San Francisco Bay; of the explorations in Alaska and the Pribilof Islands; and of the geodetic operations throughout the interior of the country. Notice is taken, also, of the forms of publication: (1) of charts and maps, and (2) the textual publications.

The aid given to the military and naval authorities in the war with Spain is touched upon. Soon after the outbreak of hostilities thirty officers were withdrawn from the service, and three vessels, the *Patterson*, *McArthur* and *Gedney*, on the Pacific Coast, were temporarily transferred by the President to the navy. On the Atlantic Coast, the *Bache* was used as a dispatch boat between Key West and Havana, and rendered important service in connection with the '*Maine* disaster.' In addition to the collation and preparation of information regarding maps of Puerto Rico, Cuba, Hawaii and the Philippines, the Survey furnished to the Navy Department, between April 1st and June 30th, over 27,600 charts.

Mention is made of the fact that at the close of the fiscal year there were 375 persons employed in the service, including petty officers and sailors. The total cost of the work is stated as follows:

Field expenses	$124,800
Vessels (including $75,000 for the *Pathfinder*,	110,000
Salaries	226,870
Office expenses	34,400
Making a total of	$496,070

To this is to be added an amount of $112,676, from the Naval Appropriation Bill, for pay and subsistence of enlisted men, as well as $45,354, for the pay of naval officers, making a grand total of

$654,100, as the cost of the survey during the fiscal year described.

Following the introduction is an historical sketch of the Coast Survey, stating briefly the phases through which it has passed since its inception, in 1807, and also giving a list of the Superintendents, from the beginning to the present time. As a matter of interest, a sketch is shown giving the outline of the first triangulation laid out on this work. It consists of 11 trigonometrical points in the vicinity of New York, suitably connected by triangulation, and determined and verified by the measurement of two base lines. This work was done as early as 1817.

Passing to the second division of the report, the scientific and technical results, we find the work classified into:

(1) Coast Work.
(2) Geodetic Work.
(3) Magnetic Work.
(4) Special Operations.
(5) Publication of Results.

Under *Coast Work*, a general statement is given of the progress made in Buzzard's Bay, Chesapeake Bay, Lake Pontchartrain, San Francisco Bay, Washington Sound and Alaska. Mention is made of some miscellaneous charts, and finally a list of hydrographic sheets is given, published through the courtesy of the United States Fish Commission, and referring to the work of the steamer *Albatross* in Southeastern Alaska, under the direction of Commander J. F. Moser, U. S. N.

The details of field operations comprise a description of the work accomplished in the different localities in hydrography, current observations, topography, etc.

Besides the regular coast work, a party was sent to the Pribilof Islands, and during the season, which was an exceptionally favorable one for surveying operations, a complete topographical survey was made of St. Paul, St. George, Walrus, and Otter islands, on the scale of 1/20,000. Not only this, but the seal rookeries, to the number of eighteen, were completely developed, and maps of them were carefully drawn, on a scale of 1/2000. These show every necessary detail, and furnish most valuable information touching upon the seal industry.

In January, 1898, an appropriation of $100,000 was made by Congress, in order that immediate information might be secured in regard to the mouth of the Yukon and other rivers leading to the gold producing regions of Alaska. Three parties were sent out in the spring, and valuable results were obtained from all the localities visited. Special attention was given to the mouths of the Yukon and Copper rivers, the region around the head of Lynn Canal, and the passes leading to the Klondike.

The work of the Coast Pilot Division is briefly stated, and mention is made of the fact that the issue of the U. S. Coast Pilot for the Atlantic Coast has increased from 1209 copies during the year 1897, to 1532 copies for the following year.

Prominent among the work accomplished in the Tidal Division during the year was the preparation and completion of Parts I. and II. of a 'Manual of Tides,' by Dr. R. A. Harris. These two parts were published as Appendices Nos. 8 and 9 of the Annual Report for 1897. It is proposed to treat the whole subject in five parts. Part III., because it was immediately wanted, appeared first, and was published as appendix No. 7 in the Report for 1894. Parts IV. and V. will appear shortly.

Part I. is a historical treatment of the subject. Part II. refers to tidal observations, the equilibrium theory, and harmonic analysis. Part II. is on connections between harmonic and non-harmonic quantities, including applications to the reduction and prediction of tides. Part IV. will treat of tidal theory; and part V. of tidal streams or currents.

The *Geodetic work* of the survey for the fiscal year considered, is treated under the subjects of reconnoissance, triangulation, hypsometry, astronomical, and gravity work. These have been carried on in all three divisions of the United States, the Eastern, Middle, and Western, and also in Alaska. Gravity work was done on the Pribilof Islands, with a standard set of pendulums.

The *magnetic work* has been generally distributed over Maryland, District of Columbia, Virginia, West Virgina, Ohio, North Carolina, California, Washington, and Alaska. The magnetic survey of Maryland, made by Dr. L. A. Bauer, under the auspices of the Geological Survey, is noted in connection with the regular work of the Coast and Geodetic Survey. This work was carried out with instruments loaned by the Survey, and in return for their use the Government was to have access to the results, when desired.

Of *Special Operations* may be cited the location of buoys, the establishment of speed trial courses for ships of the Navy; magnetic ranges and dock lines; State boundary lines, and detailed hydrographic surveys. Observers have been sent with exploring parties, where there was prospect of securing valuable geographical knowledge.

In the *Division of Publication* a description is given of the processes employed in chart production. The plane-table sheet, as it comes from the hands of the field officer, is followed through the different stages of reducing, engraving and printing, until it appears as a finished chart, ready for distribution. More than 100,000 charts were issued during the year.

Of the textual publications there are the annual reports and scientific appendices, the bulletins, notices to mariners, tide tables, coast pilot, and special publications. A bulletin, entitled, 'Tables of Depths for Channels and Harbors on the Coast of the United States,' has been issued. The regular notices to mariners, over 4000 copies of which are sent out monthly, and tide tables, which now include about 3000 ports throughout the world, were published during the year. The predicted time of every high and low water, throughout the year, is given for 70 principal ports, of which 25 are within the territory of the United States. As a special publication may be noted, 'Magnetic Ranges for Determining Deviation of the Compass in San Francisco Bay.' The catalogue of charts published by the Coast and Geodetic Survey at present contains a list of about 500 charts and maps.

Under the general head of 'Administration,' may be noted a table giving the details of field operations, followed by a summary of the work accomplished in the Office of the Assistant in Charge of Office and Topography, as well as in the Office of the Hydrographic Inspector and the Office of Standard Weights and Measures.

Under the title *Assistant in Charge of Office and Topography*, the routine work and the results obtained in the following divisions are described:

(1) Computing.
(3) Tidal.
(3) Drawing and Engraving.
(4) Chart.
(5) Instrument.
(6) Library and Archives.
(7) Miscellaneous.
(8) Disbursing.

In the report of the *Hydrographic Inspector* appear statements in regard to vessels and officers; the hydrographic section, and the coast pilot party.

The important work of the *Office of Standard Weights and Measures* is given only in outline. Much time was given by Mr. Braid, the officer then in charge, to the consideration of questions relating to sugar importation. Standard bars of length were supplied to the Ordnance Department of the Army, for use in the manufacture of great rifles. Progress was made in designing apparatus for the comparison of electrical standards; and standards of length and mass were furnished as requested, to State and municipal authorities, to corporations, and to individuals.

As a special feature in the operations of the fiscal year for which the report is made, may be mentioned the tide and current observations in Seymour Narrows, Alaska; where, by permission of the Canadian Government, a tide gauge was established, and times of slack water during day hours, from April 18th to October 14th, were observed. Predictions based on this and other information have since appeared in the tide tables, and are a valuable acquisition to the information there found.

During the year a contract was let for the steamer *Pathfinder*, to be constructed especially for the Alaskan work. She is the largest of the Coast Survey fleet, now numbering 11 steamers and five sailing vessels, and has a displacement of about 875 tons, with a steaming radius of 7000 miles. This vessel has already made the trip from New York to San Francisco, by way of Cape Horn, and has proved herself to be an admirable sea-going vessel. She is now stationed in the Hawaiian Islands, engaged in hydrographic work, but will soon come north to take up the operations for which she is especially fitted by her construction, namely, the hydrography on the rock-bound coasts of the Aleutian Islands.

The reconnoissance and the triangulation has been carried on along ninety-eighth meridian, and much progress has been made. This is later to be connected with the Mexican work on the south and the British on the north, and altogether will furnish an arc of the meridian, second to none, for the determination of the earth's figure. The great arc across Russia, from the North Cape to the Baltic, was considered a great achievement, but the combined British, American and Mexican arc will probably stand without a rival for many years to come. This, combined with the arc of the parallel, the results of which are now deduced, and the report of which is running through the press, will completely determine the earth's figure for the continent of North America.

The important connection across the Peninsula of Florida, from Fernandina on the east to Cedar Keys on the west, has been made and is reported in the present volume. This completely binds together the somewhat loose tertiary triangulation on the eastern coast with that on the western, and aids materially in the correct determination of all geographical positions on the coast of Florida.

Following the traditions of the Coast and Geodetic Survey in the question of State boundaries, assistants were detailed to aid the commissioners of Maryland and Virginia in the location of the line between the two states. This was completed in January of the fiscal year. Other important side operations were the special hydrographic examination of the Tybee Submerged Breakwater, made at the request of the War Department; services on the Mississippi River Commission; hydrographic surveys at Key West and the Tortugas, made at the request of the Navy Department; and operations undertaken in compliance with special acts of Congress. Under the last head may be stated the survey of the Brunswick Outer Bar, Ga., which, on account of the extreme accuracy required, necessitated prolonged and careful examination. Aid was given in the private expedition undertaken during the year, to Mt. St. Elias, and although the expedition was unable to reach the top, valuable information of the region was procured.

In the fourth part of the work appear the Appendices. Of these there are nine, and the subjects treated are:

Nos. (1), (2), (3) Precise Leveling, in Kansas and Colorado.

No. (4) The Peruvian Arc, its relative Value, etc.

No. (5) Physical observations made in connection with the Pribilof Islands Expedition of 1897; in which the magnetic irregularity on St. George Island, the sea water densities in the North Pacific and Bering Sea, and the determination of the force of gravity on St. Paul Island, are all treated.

No. (6) A report on the Proceedings of the International Geodetic Association, and on Geodetic Operations in the United States; comprising statements with reference to the international latitude service, gravity measures, the figure of the earth, the Peruvian arc, and the longitudes of Paris and Greenwich. Under Geodetic Operations in the United States are treated; base lines, triangulations and arcs, astronomical work, miscellaneous operations, past and future operations, and the work of the United States Engineers.

No. (7) The Determination of Time, Longitude, Latitude, and Azimuth; in which the method of making these observations and computations is treated fundamentally. This paper is the fourth edition of an appendix to previous Coast Survey reports. It is now brought up to date, and embodies the most recent knowledge on the subject. A description is given of the most approved practical methods developed from field experience during half a century.

No. (8) A Plane Table Manual, in which are given the field methods employed with this valuable and convenient instrument. The subject is treated under: I. A preliminary statement; II. The instruments and adjustments; and III. The field work. Under the latter head the three-point problem is treated at length, and numerous tables are given, among which may be noted one for computing differences of elevation, one showing heights corresponding to angles of elevation, and one giving corrections for effect of curvature and refraction.

No. (9) Problems of Physiography concerning Salinity and Temperature of the Pacific Ocean—closes the report and is treated in three heads: Bering Sea, Okhotsk Sea, and the Central Pacific Ocean.

There are 25 cuts in the body of the work, besides 55 in the different appendices. Many of these are half-tone illustrations and add materially to the value and appearance of the Report.

E. D. P.

SCIENTIFIC BOOKS.

Clark University, 1889–1899. Decennial Celebration. Worcester, Mass., Published by the University. 1899. 4to. Pp. 566.

Of the three verbs to *be*, to *do*, and to *know*, the great majority of young men unhesitatingly regard the second as expressing the ultimate purpose and end of life. This is, as a matter of course, the idea of the practical man, who knows what he wants, and does not desire to want anything else. The average trustee of an American college will think it a very commendable thing for a professor to employ all the time he can possibly save in making money; but if he devotes much energy to any purely theoretical research, the trustees will look upon him askance, as a barely respectable squanderer of his opportunities. In England, this notion takes a turn that really makes it a little less gross; yet being foreign, perhaps we can discern its error more easily than in its more familiar guise. Thus, Dr. Karl Pearson, in the introduction to his 'Grammar of Science,' deliberately lays down the principle that no end whatever is to be approved without a reason, except the end of the preservation of society; and applying this rule, declares that the only valid excuse for the encouragement of scientific activity lies in its tending to maintain 'the stability of society.' This is a truly British phrase, meaning the House of Lords and vested rights and all that. Only recently, we have seen an American man of science and of weight discuss the purpose of education, without once alluding to the only motive that animates the genuine scientific investigator. I am not guiltless in this matter, myself; for in my youth, I wrote some articles to uphold a doctrine I called Pragmatism, namely, that the meaning and essence of every conception lies in the application that is to be made of it. That is all very well, when properly understood. I do not intend to recant it. But the question arises, *what is* the ultimate application; at that time, I seem to have been inclined to subordinate the *conception* to the *act*, knowing to doing. Subsequent experience of life has taught me that the only thing that is really desirable without a reason for being so, is to render ideas and things reasonable. One cannot well demand a reason for reasonableness itself. Logical analysis shows that reasonableness consists in association, assimilation, generalization, the bringing of items together into an organic whole—which are so many ways of regarding what is essentially the same thing. In the emotional sphere, this tendency towards union appears as Love; so that the Law of Love and the Law of Reason are quite at one.

There was a simple fellow who, in a benighted age and land, wandered about uttering appreciations of the elements of human life which have made an extraordinary impression upon most of us. Of all his sayings, there is none whose truth has been brought home to me more strongly by what I have been able to detect in successful men and women than this: Whoever makes his own welfare his object will simply ruin it utterly: *ὁ εὑρῶν τὴν ψυχὴν αὐτοῦ ἀπολέσει αὐτήν.* American education, for the most part, is directed to no other object than the welfare of the individual scholars; and thereby incites *them* to pursue that object exclusively. A great university bears upon its seal the remark of its founder: "I wish to found an institution where any man can learn any thing." It was a noble idea; and it would be mean to pick flaws in it—especially as he did not say what ulterior purpose he might have in view. But the university which parades this casual remark as its motto, seems to proclaim to its students that their individual well-being is its only aim. Our scientific schools distribute circulars which dwell chiefly upon the handsome incomes their alumni are making, thereby calling up such images as a handsomely laid table with a pair of Hâvre-de-grace ducks and a bottle of Château Margaux. What comes of such a conception of education and of life, for surely, the purpose of education is not different from the purpose of life? The result is that, notwithstanding all the devices and tricks of the American teachers' art, it may be doubted whether any teaching ever anywhere did less to make happy men and women. At any rate, the spiritual meagerness of the typical American school-book is extreme. The great medieval universities, the modern German universities, the new science colleges of England, which did, and do, great things for their students personally, were never in the least founded for their students' individual advantage, but, on the contrary, because of the expectation that the truths that would be brought to light in such institutions would benefit the State. This end was, and is, so constantly in view that the scholars are led to regard their own lives as having a purpose beyond themselves.

Yet even this is a low view of learning and of science. No reader of this JOURNAL is likely to be content with the statement that the searching out of the ideas that govern the universe has no other value than that it helps human animals to swarm and feed. He will rather insist that the only thing that makes the human race worth perpetuation is that thereby rational ideas may be developed, and the rationalization of things furthered.

No other occupation of man is so purely and immediately directed to the one end that is alone intrinsically rational, as scientific investigation. It so strongly influences those who pursue it to subordinate all motives of ambition, fame, greed, self-seeking of every description, that other people, even those who have relatively elevated aspirations, such as theologians and teachers, altogether fail, in many cases, to divine the scientific man's simple motives. The Clark University, in recognizing the pursuit of science as its first object, with teaching,—of course, an indispensable means of securing continuity of work,—as only a subordinate, or at most a secondary object, has perhaps the most elevated ideal of any university in the world; and I believe it to be so much the better for the individual students. At any rate, I can only record my personal observation in two visits, after having endeavored at many universities to learn to appreciate the atmospheres of such places, that there is a sweetness and a strength there quite exceptional. I am far from regretting that the institution has been through tribulations, and has purged itself of every element alien to its idea. To-day the good seed has germinated, so that it can no longer be choked by lower motives if it now only receives what is necessary to its continuance. It is earnestly to be hoped that it may speedily find its Constantine or its Helena. If not, one can but pity the family of its founder, which will have missed so narrowly a crown of high distinction. In that case, one must believe that among the American people, so appreciative of broad ideas, there may be found some thousands of persons, who whether they are quite sure of the immeasurable superiority of the aims of Clark or not, will at any rate feel that one institution of this peculiar kind ought to exist in the land, and will come forward with annual subscriptions to enable it to tide over a prolongation of its period of trial, and to wait for the rescue that sooner or later, from some quarter or another, is sure to come. The volume before us affords indisputable proof of the extraordinary interest and respect which this small institution commands from every genuine man of science the whole world over. Mr. Clark has, at any rate, drawn the eyes of all Europe with expectation upon the city of Worcester. To allow the university, after this, to sink into nothingness would be to make a nasty smirch upon the scutcheon of America, that would long remain an offence to all our eyes.

C. S. PEIRCE.

Analysis of White Paints. A Collection of Notes on the Chemical Analysis of White and Tinted Paints. By GEORGE H. ELLIS, B.Sc., Analytical Chemist and Assayer. Late Chemist Chicago, Burlington and Quincy Railway Company. The Technical Press, Evanston, Ill. Pp. 61 + vi.

This little book is a reprint of a series of papers originally published in the *Paint, Oil and Drug Review*, and their aim is to give a detailed description of the best methods of analysis of white and tinted paints. The book is intended not only as a reference book for experienced chemists, but also as a complete manual for the use of those who have little knowledge of chemistry. Thus a full description is given of the analysis of clay. It is a lamentable fact that so many manufacturers who are just coming to feel the need of a chemist in their works, do not recognize the desirability of having as chemist one who has at least a moderately thorough knowledge of chemistry. A book like the one before us will be of great value to the inexperienced paint-chemist, and will not come amiss to others. It will be of most value, however, to those chemists into whose hands there comes only occasionally a sample of paint for analysis. Chapter 1 is on preparing samples for analysis. Chapter 2 describes the different white pigments, and their qualitative and quantitative analysis, with specimen analyses by the author. The pigments considered are calcium carbonate, gypsum, china clay, silica, barium sulfate, magnesium carbonate, magnesium silicate, zinc oxid, and white lead. Chapter 3 presents schemes for the analysis of mixed paints, a problem often difficult owing to the presence of several different pigments as well as perhaps adulterants. The methods given are excellent and are described with clearness. The use of barium carbonate as a white pigment is referred to only in a brief note, where it is stated to be little used in American paints. I do not recall having seen any mention elsewhere of its use, but a highly praised paint came into my hands lately, which consisted of nearly equal parts barium carbonate and zinc oxid.

An appendix gives a brief scheme for the estimation of turpentine, benzin and water, a list of the principal pigments with their trade names, atomic weight table, and metric conversion table. The book has a full index. It is to be hoped that the author will supplement this book by a similar one on colored pigments and tints and their analysis.

JAS. LEWIS HOWE.

The Refraction of the Eye, Including a Complete Treatise on Ophthalmometry. A Clinical Text-book for Students and Practitioners. By EDWARD DAVIS, A.M., M.D., Adjunct Professor of Diseases of the Eye in the New York Post-Graduate Medical School and Hospital, etc., with One Hundred and Nineteen Engravings, Ninety-seven of which are Original. 8vo. Pp. XII, 431.

This book as indicated in its sub-title is practically a treatise on Ophthalmometry. Replete with illustrative cases showing the most accurate and the most certain of the methods that are employed by the author for the examination and correction of errors of refraction, it serves as an excellent clinical guide for both the beginner and the experienced practitioner in this particular line of ophthalmic practice.

Well written, devoid of confusing diagrams, and most comprehensive in its every detail, it can be safely asserted that the book is by far the best exposition of the value and the use of the ophthalmometer that we have in our possession at the present time.

Both the author and the publisher are to be congratulated upon the production of a valuable work. C. A. O.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, January. 'On the Inversion of the Hepta- and Hexa-hydrates of Zinc Sulphate in the Clark Cell,' by H. C. Barnes; 'The Melting Point of Chloral Hydrate,' by C. G. L. Wolf. The conclusion is drawn that but one modification of chloral hydrate exists in the fused substance and that the observed differences in melting point are due to dissociation. 'The Relation of the Taste of Acid Salts to their Degree of Dissociation,' by Louis Kahlenberg. The author finds that the sour taste of solutions of acid salts is much stronger than would be accounted for by the theory that acid taste is due to free hydrogen ions. 'The Electro-Chemical Equivalent of Carbon,' by H. C. Pease. The value for carbon when anode in concentrated sulfuric acid has been already determined; the author finds the value in fused potassium hydroxid (that is in a Jaques' cell), to be three, as in the acid. Carbon in both these conditions is thus quadrivalent. In the February number: 'On the Emission and Absorption of Water Vapor by Colloidal Matter,' by P. Duhem, an extended mathematical treatment of the subject. 'The Melting-point of Formyl-phenyl-acetic ether,' by C. G. L. Wolf. 'Freezing-point Curve for Water containing Hydrochloric Acid and Phenol,' by J. A. Emery and F. K. Cameron. The depression of the freezing-point of water by hydrochloric acid and phenol is in general an additive effect. 'Note on Bunsen's Ice Calorimeter,' by J. W. Mellor; preparation of an air free water and filling the calorimeter therewith.

IN *The Osprey* for March, Paul Bartsch continues his 'Birds of the Road' discussing those seen in February and March about Washington. Eugene S. Rolfe describes 'Some Trials of a Field Collector' and J. P. Norris discourses of the 'Eggs of the Sandhill Crane.' Under the caption 'Biographies of Ornithologists' Theodore Gill contributes a first installment of a welcome sketch of Swainson. The editor promises other biographies and in commenting upon the mercantile value of eggs makes some interesting remarks on the 'impulse to collect something' that seems inborn in man.

The American Naturalist for March opens with a paper by P. Calvin Mensch 'On the Life History of *Autolytus Cornutus* and Alternate Generation in Annelids' in which the author reaches the conclusion that in *Autolytus* we do not have a sexual generation alternating with an asexual, but a sexual dimorphism. Frank R. Lillie presents 'Some Notes on Regeneration and Regulation in Planarians,' and W. W. Norman has some 'Remarks on the San Marcos Salamander, *Typhlomolge orathbuni* Stejneger' which include some excellent figures of this little salamander. C. F. W. McClure writes 'On the Frequency of Abnormalities in Connection with the Postcaval Vein and its Tributaries in the Domestic Cat (*Felis domestica*)' concluding that breeding experiments might give us some clue to their causes. J. A. Allen reviews 'The North American Jumping Mice' and L. Murbach treats of 'Fresh-Water Aquaria.' The Synopses of North American Invertebrates are continued by Harriet Richardson who discusses 'The Isopoda.' The balance of the number is devoted to numerous reviews of current literature.

THE plates for the April number of *Rhodora*, Journal of the New England Botanical Club, were destroyed in the recent fire at the Heintzemann press-rooms in Boston. The appearance of the April and May issues of *Rhodora* will necessarily be somewhat delayed.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY AND PHYSICS.

A MEETING of the Section was held on Monday evening, February 5th. Professor J. K. Rees presented a report on November meteors. Arrangements were made by the Columbia University observatory to observe and photograph the meteors during the week of November 12 to 18, 1899. At West Point, Dr. S. A. Mitchell, assisted by Messrs. Bauer and Jenkins, was provided with a Rowland concave grating and two cameras. No photographs however were obtained. At Bayport, L. I., Mr. C. A. Post had placed his observatory and his services at the disposal of the Columbia observatory staff. Six cameras and two telescopes were made use of. On one plate in a camera provided with a Goerz lens, a photograph taken on November 15th, between 16 h. 9 m. 30 sec., and 16 h. 40 m. 44 sec., when pointed near Procyon, showed a meteor trail. Dr. Elkins of the Yale observatory will measure this plate.

A number of students and others watched for the meteors for the purpose of counting them, at West Point, New York, and Bayport. At West Point, in about four hours on November 15th, 17 meteors were seen of which 12 were Leonids. In New York on the same evening, three observers counted 68 in about 5 hours. Two other observers counted 36 in 2½ hours. At Bayport, two observers counted 39 in about 3½ hours.

Professor Rees, observing casually while attending to the photographic apparatus at Bayport, observed a first magnitude Leonid at 15 h. 29 m., on November 15th, between the two lowest stars in the handle of the Dipper. At 15 h. 39 m., he observed another first magnitude Leonid under Sirius. At 17 h. 15.5 m. a fine Leonid trail, lasting 3 seconds, was seen over Procyon. At 17 h. 30 m. a very bright Geminid was seen 20° south of Regulus.

Professor Rees also presented a paper on the variation of latitude, and the constant of aberration of light, as determined from six and one-half year's observations made at the Columbia University latitude observatory. Observations of latitude were made at the new site of Columbia University from April 24, 1893, to the present time, and will be continued until May 1, 1900. The observers were Professors Rees and Jacoby, and Dr. H. S. Davis. A zenith telescope made by Waunscaff of Berlin, was employed throughout. Its aperture is 80 mm., and its focal length is one meter. Four groups of stars were used, having mean right ascensions of about 6 h., 14 h., 18 h., and 22 h. respectively. Each group contained seven stars. Up to the present time, 6518 pairs have been observed on 758 nights. From the observations, a curve was drawn showing the latitude. This was compared with the curve required by Dr. S. C. Chandler's formula (*Ast. Jour.*, No. 446). From 1896, the observed epochs of maxima and minima seem to follow the computed in time.

These observations give for the constant of aberration of light the value

$$20''.464 \pm 0''.006.$$

Mr. George H. Bauer read a paper on the parallax of μ Cassiopeiæ and the positions of 56 neighboring stars, as deduced from the Rutherfurd photographic measures. This star has a large proper notion, and measurements of its parallax have been made by various methods and observers. The present determination is based on 28 Rutherfurd photographic plates, and the method of position angle was used in measuring them, as Professor Jacoby has already made a reduction using the method of distance. Eleven independent determinations were made giving a value of

$$0''.238 \pm 0''.014.$$

Professor Jacoby found by the method of distance $0''.275 \pm 0''.024$. These results agree even better than might have been expected. In forming the catalogue of 56 stars about μ Cassiopeiæ, the usual corrections for refraction, precession, nutation, aberration, proper motion, etc., were applied. Since the co-ordinates were measured in distance and position angle, these were then converted into difference of right ascension and declination. After finding the positions for the epoch 1872.0, the precession and secular variation were computed and tabulated.

WILLIAM S. DAY,
Secretary of Section.

SECTION OF GEOLOGY AND MINERALOGY.

AT the meeting on March 19, 1900, Mr. G. F. Kunz presided, and forty-nine persons were present.

The secretary announced that this section and the Biological section had been requested to nominate candidates before April 20th, for the grant of the Newberry Research Fund, the grant this year being restricted to those working in botany and geology. Authority was granted to the chairman and secretary of the section to make such nominations to the council.

The chairman announced the course of lectures on 'The Principles of Geology' to be delivered at Johns Hopkins University in April, under the G. H. Williams memorial lectureship, by Professor W. C. Brögger, of Christiania; also the receipt of the program of the International Geological Congress, at which the Academy would be represented by Professor J. J. Stevenson.

The chair announced the death of Doctor Oliver P. Hubbard, one of the earliest members of the Academy. On motion of Professor R. E. Dodge, a committee of three was appointed to draft resolutions on the death of Dr. Hubbard, and the chair appointed Dr. Julien and Professor Stevenson such a committee.

Professor Stevenson presented the following minute upon the life of Dr. H. B. Geinitz, whose death was announced at the February meeting.

Professor Dr. Hans Bruno Geinitz, for many years an honorary member of this Academy, died January 28, 1900, in the 86th year of his age.

His work as a geologist began very early, for in 1837, when only twenty years old, he published a paper on the 'Muschelkalk.' From that time until within a few weeks of his death brief notices, memoirs and volumes appeared in rapid succession. There seemed to have been no limit to his capacity for hard work. He studied the Cretaceous, Triassic and Carboniferous in detail, and his works on the coal fields of Saxony and Germany were marvels, when published, almost half a century ago. His papers on paleontology, vertebrate and invertebrate, and paleobotany are numerous and important.

He was put in charge of the Royal Mineralogical Cabinet at Dresden in 1846 and retained the position until 1898. The collections increased rapidly, so that, in 1857, the Royal Cabinet became the Royal Museum which in later years was one of the chief attractions for foreign visitors. In addition to his other labors, he was professor of mineralogy in the Royal Polytechnic school of Dresden from 1850 to 1896, serving meanwhile upon numerous government commissions.

Professor Geinitz was a typical student, caring little for things of this world, devoted to geology and his family. He was genial, sincere, a tender father, a generous friend. By his death German science has lost one of its most conscientious workers and Saxony one of its most respected citizens.

Dr. Alexis A. Julien and Dr. Theodore G. White were unanimously elected chairman and secretary, respectively, of the section for the ensuing year.

Dr. Henry B. Kümmel, Assistant State Geologist of New Jersey, read a summary of the information thus far collected in regard to the geology of 'The Palisades' of the Hudson river, illustrated by numerous views, many of them taken by Mr. Prince, of Orange, N. J. Most of the details of the paper will be found in the 1897 Report of the State Geologist of New Jersey. Observers are nearly all agreed that the Palisades are an intrusive trap sheet which has cooled at great depths. The basal contact is observable at 19 localities, in 15 of which the trap is unconformable upon the sandstone and shales beneath, and is penetrated by tongues of the latter, and in three is apparently conformable. The altitude of the lower contact increases from the south to the north, where it reaches 200 feet elevation. The upper contact is seen in six localities. At three of these, dikes penetrating the overlying shales occurred at the contacts, in two the contact is unconformable and in one conformable. In every instance the beds superjacent to the trap are metamorphosed. In no locality of the Palisade range proper does the upper contact of the trap show any of the characteristics of surface cooling. Well-borings at Fort Lee penetrate 875 feet of trap, and the total thickness probably exceeds 950 feet, much erosion having taken place. Subsequent to deposition of the underlying sandstones the area was tilted, and the sandstone wasted away by erosion of many streams, the vacant channels of which are still present. The largest of these stream gaps was one and a half miles wide and is just north of the New Jersey state boundary. The cutting of gaps throughout the dissected tilted peneplane which remains was very uniform and indicates that the former land level was 220 feet lower than the present. If this is the case we have an instance of rivers beheaded close to their mouths. In addition to the wild beauty of the Palisades escarpment, the timber of this tract is the most luxurious and valuable of the State of New Jersey, although its area is much less than that of the pine groves of the south.

Professor John C. Smock, State Geologist of New Jersey, followed with an account of the efforts expended 'On the protection of the Palisades' from devastation by quarrymen. Legislative prohibition of such destruction is retarded by (1) lack of interest in the matter on the part of residents of southern New Jersey, (2) prospects of the future commercial value of the riparian lands at the base of the cliffs for purposes of shipping and manufacturing, which the removal of a portion of the cliffs would render available, (3) the present value to the state of its quarrying interests along the water front, (4) the income derived from riparian grants of these lands from the state to the quarrymen, which is devoted to the maintenance of the public schools, the approximate value to the State for this purpose of the lands from Fort Lee to the State border being about one million dollars. This clash between the interests of the schools and the preservation of beautiful scenery is the most serious obstacle with which legislation against defacing the Palisades has to contend.

In the face of these obstacles it is evident that the wholesale absorption of this territory for a purely sentimental object is impossible. The opposition to such a scheme could only be broken by years of fighting, and in the meanwhile the destruction of the cliffs and wooded slopes would continue with ever-increasing extent.

As a compromise Professor Smock proposed that an interstate commission of New Jersey and New York lay out a driveway along the base of the Palisades, quarrying, manufacturing, and shipping interests to be confined to the water side of the driveway, and the cliff side to be permanently preserved intact after the drive is completed. Edinburgh, Quebec and Sterling were cited as exhibiting rocky heights whose grandeur was enhanced by the fringe of manufactories at their base, such buildings lending a basis to the eye by which to measure the proportions of the cliffs. Cliff defacement is also in progress upon the New York Palisades, where are the grandest wooded slopes and highest peaks. There is no need of encroachment on the cliffs, in either State, for there are many other places where as good material exists in equally great quantities and can be mined at practically the same expense.

Whatever is done should be done at once, or else we shall have lost a great part of the scenery which we wish to preserve. Steps should be taken to turn into a vast park as much of the territory as it is practicable to preserve, without destroying or coming in contact with the large public and private business interests that are involved.

In discussion Mr. Kunz voiced the sentiment that the opposition to legislation arose more with the officials at Trenton, than with residents of southern New Jersey, and felt that smoke and other nuisances from factory settlements along the cliff would be seriously detrimental. Were a restricted park created the value of residential property would in a few years benefit the State many times over the value of the riparian grants. Railroad tunnels might be permitted at distances of a few miles apart, with commercial villages at their waterfront terminals. The stone from such tunnels would defray the cost of quarrying.

Dr. Levison suggested that the removal of portions of the talus would increase the apparent height of the cliffs, if blasting of the latter could be prevented.

Professor Dodge described the similar trap formations of Connecticut.

After a vote of thanks to both lecturers the meeting adjourned.

Theodore G. White,
Secretary of Section.

DISCUSSION AND CORRESPONDENCE.

THE PLUMAGES AND MOULTS OF THE INDIGO BUNTING (*Passerina cyanea*).

It is no new idea that the Indigo Bunting changes color without moulting, but just as one swallow does not make a summer, neither does one bird make 'aptosochromatism' an assured fact. This, however, is what a recent writer (Birtwell, Science, N. S., Vol. XI., Feb. 23, 1900) would have us believe, and yet there is quite a different way of looking at his supposed facts which suffer from the very 'individual error and dogmatism' he deprecates in others. He says "It is a singular fact that certain individuals have conceived the idea that a feather once having passed its premature condition (what may this be, please?) is utterly disconnected with the vital system of the bird and such individuals cling to this belief with a tenacity wonderful to behold." Doubtless it does seem 'wonderful' to persons who would wave aside all the careful observations that have been made upon feather growth and feather wear, and plumage generally, but possibly it is not so wonderful as the strange things they see just as soon as they watch a bird of striking colors in a cage. It is well to understand some elementary and fundamental facts that are self evident before having recourse to theoretical explanations, and lest Mr. Birtwell's conclusions be taken too seriously, it is my present purpose to first explain the plumage changes which regularly occur in the wild Indigo Buntings and then show why observations upon caged ones are open to doubt.

The Indigo Bunting regularly moults twice every year, differing in no wise in this respect from many other species, and like some of them it is also peculiar in requiring several moults to reach the adult plumage. This is what usually takes place in highly-colored species, and another peculiarity, if such it may be called, is the retention at the time of one moult of the feathers of certain areas until a later period of moult, a mixture of older and newer feathers in juxtaposition being the result. The key to the whole matter lies in understanding the principle of *sequence of plumages* as I have called it (*Auk.*, XVI., 1899, pp. 218–220, pl. III. and XVII., 1900, pp. 34–43) which is adequate to explain all parti-colored plumages without recourse to theory. I regret, that owing to unfortunate delays another article which explains the principle and its application at more length is still in press, so that it is not at present available for reference.

To understand clearly the successive stages of plumage in the Indigo Bunting it is desirable to take them up in the order in which they occur.

Natal Down.—On hatching, the chick is sparingly clothed with long downy filaments, the precursors of the definitive feathers to the apices of which they are attached. The down varies very little among the many species of Passerine birds.

Juvenal Plumage.—This second stage succeeds to the downy, part of the feathers being acquired before the bird leaves the nest. Brown is the prevailing color, paler below with streaks most obvious on the breast. In females the remiges and rectrices are wholly brown also, but in males they usually have a greenish blue tint most marked in the tail and varying in intensity according to the individual. The body feathers are looser in texture than are those of the next stage, assumed by the postjuvenal moult which occurs in the latitude of New York during August and September.

First Winter Plumage.—The third stage of plumage, commonly known as the 'autumnal,' is similar to the previous one, the moult usually involving only the body feathers. In males, the feathers of the throat especially become basally more or less tinged with dull blue, the females remaining dull brown and gray. Some males, however, assume by a more complete moult a new tail and several, usually, five or six, distal primaries which are nearly black and distinctly edged with bright blue. Indisputable proof of moult in the shape of such feathers still in their sheaths, is furnished by a couple of birds in the collection of Mr. Wm. Palmer (No. 3283, September 17th and No. 3655, October 2d, Washington, D. C.). I am of opinion that it is perhaps only southern breeding birds that moult so completely at this season, for no northern specimens show it. Immature birds from semi-tropical localities taken during the winter months have either brown edgings or blue edgings to the remiges and rectrices and should not be mistaken for adults which have dark, blue-edged primary coverts, instead of the wholly brown ones which are characteristic of the young bird. It is probable that young birds, when they acquire precociously new wings and tail at the postjuvenal moult, like adults, do not again moult then until the following autumn; but we do know that most brown winged birds acquire five or six distal primaries, a new tail and body feathers besides at a prenuptial moult. Two birds in the New York National Museum (Nos. 107844–45 Bahamas, W. I., March 11th) prove actual growth of all these feathers, the worn brown primary coverts being retained and many summer specimens furnish evidence of having passed through a moult before reaching their breeding grounds, the relative amount of wear the different feathers show proving them to be of different ages. Very little is known about the prenuptial moult in most species and it appears to be in many of them a somewhat irregular affair spread over a number of the winter months, but there is ample evidence of its occurrence, the time, however, being the only puzzling feature.

First Nuptial Plumage.—The fourth stage of plumage in the Indigo Bunting results from the prenuptial moult which, as in most young birds, is more or less incomplete. Consequently we find breeding males almost wholly bright blue or with only a scattering of blue feathers mixed with the brown, gray or dull blue worn ones belonging to the first winter plumage. The individual variation is great, but all young birds may be differentiated by the ragged brown primary coverts. Females undergo very little moult and often none.

Second or Adult Winter Plumage.—In August, after the breeding season and relatively earlier than the time of the postjuvenal moult, the first postnuptial moult takes place. At this time all feathers are renewed in both sexes and the identity of young and old is lost in most cases, the former now acquiring for the first time blue-edged primary coverts like those of the latter. It is probable that a few year-old birds do not assume primaries and coverts as deeply blue as older birds, for in some winter specimens these are dull, but the majority do, as proved by birds taken in the midst of the moult. Specimens of adults in winter or 'autumnal' plumage, as it is commonly called, are scarce in collections chiefly because the adults migrate southward as soon as the moult is completed. The remiges, their coverts and the rectrices now acquired are, unlike those of the juvenal stage, worn for a twelvemonth; the body feathers, largely blue with rusty-brown tips which conceal much of the blue, are, on the other hand, like those of the juvenal stage, renewed by a prenuptial moult, the second. I have examined birds in the U. S. National Museum, and in the American Museum of Natural History, taken in Mexico, Yucatan and elsewhere which show new growing blue feathers at various points on the body, such specimens bearing dates of February and March. It is of interest to note in passing that the bright blue feathers assumed either in young or old show a different structure from those of the winter plumage when examined under the microscope and cannot be mistaken for them. The barbs are much more lanceolate than those of the winter dress.

Second or Adult Nuptial Plumage.—As just indicated the adult breeding dress is acquired by a partial moult which does not include the wings nor the tail which are renewed in the young bird. Before the prenuptial moult takes place the blue of the body feathers is exposed more or less by the wearing away of the feather tips, and birds often appear brighter than they do in the fall, but the moult itself is more complete upon the body than in young birds and fewer old worn feathers will be found upon adult summer specimens.

It is not necessary to trace the moults and plumages further for later ones are but repetitions of those already explained, and the few birds which show immaturity during their second breeding season are certain to acquire fully adult colors at the second postnuptial moult, if they failed to do so at the first.

Here then we have the facts about the Indigo Bunting, and any specimen taken at the proper time of year will verify them. Nevertheless, Mr. Birtwell thinks that "for good results in investigations upon color change one should operate rather upon live birds in confinement." Well, perhaps so, for the 'proof' of color change without moult certainly does rest chiefly upon caged birds. The fact that they moult irregularly and often at long intervals and, as for instance in the case of the Purple Finch (*Carpodacus purpureus*), having once lost their bright colors may never again regain them does not seem to impair belief in a theory fifty years and more old. It began when most people were ignorant of the fact that birds could and did moult twice in the year. This was sagely declared to be too great a drain upon their vitality, but when it was found that some species did moult twice, theory had to be reserved for others that did not appear to be guilty of draining their vitality. When these in turn were proved to moult twice, refuge was taken in the assumption that only certain individuals of certain species changed color without moult. Later came red-handed proof of guilt in feathers found growing upon these individuals and the believers in theory fell back upon the claim that although one feather did seem to be renewed by moult, the one next to it underwent a color change, concerning the nature of which no two believers were agreed. Some of them have gone so far as to assert rejuvenation of frayed feather edges by some sort of exudative processes which only need to be carried a step farther to elimate altogether the necessity of moult. This is no fancy picture and I only paint it that my readers may know what 'aptosochromatism' represents.

Now, Mr. Birtwell comes forward with evidence convincing him of the growth of new feathers which expand of the wrong color and then undergo a change to blue, at the same time that the balance of old feathers also change. He kept an Indigo Bunting in a cage and, wiser than his predecessors, who have seen caged birds change color without loss of a feather, placed a 'fender' about it, resulting in the capture of over 1300 cast-off or moulted feathers! He tells us that the change to the blue in the new dull feathers had progressed 'excellently' when the bird died so that to this event he evidently attaches no importance. I do, and my opinion is that the dull feathers were deficient in color as is frequently the case in caged birds and never would have changed to blue had the bird lived. The blue he saw was either exposed by the wearing away of old feathers originally blue, or it belonged to new feathers the growth of which he failed to observe until the feather sheaths were lost. It is extremely easy to overlook growing body feathers which may be small and take but a few days to develop. The temptation is to make actual examinations of a struggling bird at long intervals and see the rest of the changes we want to through the bars of the cage, and I speak from experience with several birds. An adult male Indigo Bunting that I kept through the winter and up to July lost practically no feathers and yet members of my household were confident he was changing to blue and so he was by imperceptible loss of feather edgings. His cage was in a bag of mosquito netting such as I would commend to observers who cannot find feathers while a bird 'changes color.'

Now, of course, all the theorizing and microscopic evidence offered in Mr. Birtwell's article is not of the slightest importance if his bird did not do exactly what he claims it did, and I have already indicated some of the possible sources of error in observation. An observer who did not know the plumage differences between the adult and the young bird, nor discover the structural differences between autumnal and nuptial feathers, nor hesitate to look for 'carrier pigment cells' under the microscope, may well have his accuracy of observation questioned. These are some of the things that do not tend to inspire us with confidence in Mr. Birtwell's well-meaning and painstaking article for the narrowness of his horizon prevents facts being seen in their true light. It is so easy to be mistaken, and a mountain of theory resting upon a tiny and insecure base of alleged fact has ere now brought the *Chromatist* to grief. When the well-established laws of feather growth and feather loss fail to account for plumages, it will be time enough to adopt theories demanding new life in epidermal structures, that for many months have been histologically dead. The existence of such a thing as 'aptosochromatism' will hardly be proved by those who have no grasp upon fundamental principles, and as long as such observers expect to be taken seriously, they must not be surprised if they are called sharply to account.

JONATHAN DWIGHT, Jr.

NEW YORK.

INDIAN PICTOGRAPHS ON THE DAKOTA SANDSTONE.

THE Dakota cretaceous formation which extends from northeastern Nebraska to southwestern Kansas is composed of massive ledges of sandstone alternating with beds of shale and clay. These ledges weather out and in many places form precipitous walls from ten to fifty feet high.

It is upon these walls that the Indians have written their history in pictographs. Traces of the drawings may be seen on dozens of cliffs in the two states. Old hunters and cattlemen tell us that twenty years ago or more the chalk cliffs of the Niobrara cretaceous in western Kansas were also covered with these inscriptions. But they have already disappeared because of the soft material composing the wall upon which they were carved. The Dakota sandstone being somewhat harder is consequently not so easily worn away and many of the drawings are still legible.

Not infrequently the sandstone wall in the immediate vicinity of one of the springs which abound in the Dakota will be covered with these hieroglyphics. This is the case at the Santee caves on the Platte river opposite Ashland, Nebraska, and at the noted cave section in Ellsworth county, Kansas. Again some prominent cliff or land-mark has evidently been selected. Pawnee rock on the old Santa Fé trail, the spot forever wedded to a tale of terror, was formerly covered with pictographs. The face of the rock has since been blasted away for building stone. A cliff of yellow sandstone standing boldly out on the north bank of the Smoky Hill river near the mouth of Alum creek contains some of the finest pictographs in the region.

In 1867 Dr. F. V. Hayden, United States Geologist described some pictographs near the Blackbird mission on the Missouri river some twenty miles south of Sioux City, Ia., as follows:

"About two miles above the mission the hills are cut by the river so as to reveal vertical bluffs, the rocks of which in the distance have a yellowish-white appearance and from this fact are usually called chalk bluffs. * * * This is perhaps the finest and largest exposure of the rocks of this group along the river. The mural exposures of soft sandstone present good surfaces for the Indian to make use of on which to write his rude history. And on the chalk bluffs there are many of these hieroglyphics in positions totally inaccessible to the Indian of the present time. None of them now living know anything about them and it is supposed that they must be very ancient, and that, since they were made, great changes must have been made in these bluffs by the waters of the Missouri. These markings are at least fifty feet above the water and fifty feet or more below the summit of the bluff, so that they must have been made before the lower portion of the bluff was washed away by the Missouri. It seems strange that none of these hieroglyphic writings which occur quite often on the chalk-rocks of the Niobrara group higher up the Missouri are known to any Indians now living. The creek near by is called in Dakota language the creek where the dead have worked on accounts of the markings on the rocks."

The pictographs referred to by Dr. Hayden may still be seen, although many of them are now practically obliterated.

Not infrequently these inscriptions occur in obscure cañons or lonely cliffs. The sandstone was easily scratched and the artist was evidently not seeking notoriety. Examples may be cited in a cañon five miles east of Kanapolis and in Cameron's draw near Belvidere, Kansas.

The writer has neither the ability nor inclination to discuss these picture writings from an ethnological standpoint. Doubtless the figures had a meaning, not only to those who drew them, but also to their contemporaries. Such writings are found in many, perhaps all parts of the country. Human figures, horses, weapons, birds and symbols are the most common forms represented. In one place a man is seen leading seven ponies. Again the gigantic figure of a man about fifteen feet in length is reclining. Spears, shields, eagles, turtles, men on foot and horseback are scattered over the surface of the rocks in apparently endless confusion.

The soft sandstone is rapidly weathering away. In many places only mere outlines of the figures remain. Often the entire face of the cliff will fall off. It is but a question of a few years when the last trace of the figures will be gone. But more destructive than the ravages of time is the vandalism of man. It would seem that every white man who has visited these localities has felt it incumbent upon him to scratch his own name on the rock. This of itself might be considered only an exhibition of poor taste, were it not for the fact that he has almost invariably chosen to carve his own plebeian name over a pictograph. And with characteristic American thoroughness the scrawling letters are so broad and deep that the older figure is usually obliterated. Thus it is that many of the best examples of Indian picture writing have been and are being destroyed. Unfortunately there seems to be no way to prevent this vandalism. In a few years these records of a forgotten people shall have disappeared.

Charles Newton Gould.
University of Nebraska,
February 10, 1900.

SYSTEMATIC ARRANGEMENT OF ORE DEPOSITS ON A GEOLOGICAL BASIS.

There has been, of late years, a growing tendency to consider ore deposits from a geological standpoint. Heretofore it has been the general custom to almost ignore the physical character and structure of the rock formations with which given ore bodies are associated.

As some sort of comparison must be necessarily made between ore bodies as they are developed, their classification crude though it is, begins to take place early in their consideration. With the ordinary miner such a scheme is strictly empirical, according to some obvious features presented. From this to a scientific plan the step is a long one.

Why the classification of ore bodies has remained so long in an unsatisfactory state, and little or no real progress made, while other related branches of knowledge have advanced with gigantic strides, finds its chief explanation in the fact that our methods of investigating the phenomena connected with the alteration of rocks generally were inadequate. Until the beginning of the last quarter of our century these methods were advanced but little beyond what they were a hundred years before. The activity in natural science studies was in other directions.

With the application of the microscope to the rocks and the opening of a new world to the geologist as vast and as interesting as that which the same magnifying glass gave to the biologist, rock metamorphism assumed a new rôle. Ore formation is found to be merely a special phase of general rock alteration. It goes on under the same conditions and by the workings of the same geological processes.

The study of ore genesis and relationships of ore bodies has become a strictly geological proposition. The recent investigation of the ores from the standpoint of geology appears to be capable of producing good results. It is replete with suggestive inference. With modern geology as a foundation the near future cannot but open up to us unheard of and unthought of advantages in the practical development of the ores. We stand on the threshold of a new era.

On this topic we get a glimpse of the general trend of modern thought respecting the genesis of ore deposits by reference to the principles, formulated by Prof. C. R. Van Hise in his treatise on the general metamorphism of rocks (not yet published), as adapted recently to ore deposits. This summary is contained in his paper on 'Some Principles controlling the Deposition of Ores,' read at the Washington meeting of the American Institute of Mining Engineers.

So far as the classification of ore deposits is concerned we appear safe in concluding that:

(1) The chief feature wherein the classificatory scheme hereafter presented differs from others, is in the prominence given to geological occurrence and the direct operation of the geological processes as essential factors in the genesis of the ore bodies.

(2) The nearest possible approach to a purely genetic classification of ore deposits is believed to be found in their geological relationships, as determined by the great geological processes and not in their direct chemical formation, or physical shapes.

(3) The chemical reactions so widely used as criteria of ore classification are to be regarded as general agencies and therefore they are not available in the specific determinations of the various groups of ore bodies.

(4) In the discovery and exploitation of ores, structure is of first importance; not so much the structure of the individual ore body itself as the geological structure of the enclosing country rocks.

(5) The primary groupings of ore bodies appear to be best indicated when based upon their geological occurrence, as governed by the nature of geological processes operating.

(6) The secondary groupings appear to be best based upon the general form of the ore-bodies as geological formations produced by the grander categories of geological agencies.

(7) The ternary groupings are best based upon the specific phases of the geological processes involved in the formation of ores as ore bodies.

(8) The source of the ore materials is an unessential factor in their classification; the great practical question is, how are ores best exploited? In this connection it matters little what was the original condition of the ores. Nor have we to do very much with the detailed, complex, and usually theoretical reactions that are supposed to take place before the final stage of the ore, as we find it, is reached.

(9) Very similarly appearing ore-bodies may be formed by very different methods, a fact which, while apparent in all classifications, does not necessarily vitiate any.

(10) The present scheme is merely suggestive. It is the barest outline of what is believed to be capable of much further expansion and development into a comprehensive, rational and practical general plan.

CLASSIFICATION OF ORE DEPOSITS.

GROUPS.	CATEGORIES.	MINERS' TERMS.
I. HYPOTAXIC (Mainly Surface Deposits.)	Aqueous transportation. Residual cumulation. Precipitative action.	Placers, beds. Pockets (in part), some breccias. Bog bodies, bedded veins, layers.
II. EUTAXIC (Chiefly Stratified Deposits)	Emponded amassment. Selective dissemination. Fold filling. Crevice accretion. Concretionary accumulation. Metamorphic replacement.	Some masses, segregations (in part). Impregnations (in part). Saddle-reefs. Gash veins, some stock-works Nodules, some bands. Fahlbands (in part).
III. ATAXIC (Largely Unstratified Deposits.)	Magmatic secretion. Metamorphic segregation. Fumarole impregation. Preferential collection. Shearing satiation. Fault occupation.	Masses (in part), some lenses Stocks. Contact veins, some impregnations Chambers (in part), some pockets, linked veins. Attrition veins, some disseminations. True veins, some linked veins, lodes.

CHARLES R. KEYES.

NOTES ON INORGANIC CHEMISTRY.

THE work of H. Brereton Baker on extremely dry gases is continued by a paper on the vapor densities of dried mercurous chlorid and dried mercury, read before the Chemical Society (London). It is found that perfectly dry mercurous chlorid at 443° in an atmosphere of nitrogen shows a density of 217.4 which corresponds to the formula Hg_2Cl_2. The undried substance gives a deeper density of 118.4° showing that the dissociation of mercurous chlorid like that of ammonium chlorid is dependent on the presence of water vapor. The density of dry mercury on the other hand was found to be 108.1 at 448° showing that at this temperature the molecule of mercury is monatomic.

The same evening two papers were read by A. Scott, one on the preparation of pure hydrobromic acid in which the employment of sulfurous acid is recommended in the place of amorphous phosphorus. It is very difficult to free the phosphorus completely from chlorin, and arsenic is almost always present, which gives rise to arsenious bromid in the hydrobromic acid and arsenites and arsenates in the bromids made from this acid. When sulfurous acid is used, the hydrobromic acid is easily freed from the sulfuric acid formed by two or three distillations, the last over barium bromid.

THE second paper by Mr. Scott was on a new sulfid of arsenic, which is obtained in the process of purifying phosphoric acid from the small quantity of arsenic derived from the impurity in the phosphorus used. The new sulfid has the formula As_3S, and unlike the other sulfids of arsenic is insoluble in ammonia and ammonium sulfid, but is soluble in ammonium polysulfid, and is decomposed by caustic potash.

IN the last *Berichte* of the German Chemical Society, L. Vanino and O. Hauser call attention to an interesting reaction of lead peroxid. When it is exposed in a dry or even moist condition to a current of hydrogen sulfid, it glows brightly and the hydrogen sulfid burns with the blue flame of lead. The reaction is not only suitable for a lecture experiment on its own account, but it may be utilized for the ignition of explosive mixtures. Wet gun cotton is instantly exploded, and so are picrate powders, powdered metals such as aluminium, zinc and bismuth burn with brilliancy. Silver and bismuth peroxids act in a similar manner to lead peroxid, cobalt and copper peroxids become much heated in hydrogen sulfid, but do not ignite it, while red lead, pyrolusite, and freshly precipitated peroxid of manganese do not show the reaction.

IT has lately been discovered by Moissan that metallic calcium is soluble in liquid sodium. On cooling the calcium separates out in brilliant white hexagonal crystals of the pure metal. The mass of sodium and calcium is put in absolute alcohol at 0° when the sodium is gradually dissolved out and the crystals of calcium remain. The metallic calcium is obtained by the action of metallic sodium on calcium iodid and the whole process carried out in a closed iron crucible in one operation. Crystals of calcium may also be obtained by electrolyzing fused calcium iodid at a low red heat.

A PAPER has recently appeared in the *Bulletin* of the French Chemical Society, by A. Gautier, on the normal occurrence of arsenic in animals, including man. It appears to be always present in the thyroid gland, in lesser quantities in the thymus and the brain, while traces are always present in the skin and hair. It does not appear to be in any other organs of the body, and consequently would play little part in the toxicology of arsenic, as these organs are rarely used for the detection of arsenic; the brain, however, is sometimes examined. The arsenic appears to be in the form of nucleins.

J. L. H.

TOBACCO, TOBACCO-PIPES AND SMOKING.

PERHAPS the most American of all implements and practices, the above have been described and figured hundreds of times, but never in so scientific a spirit as by Joseph D. McGuire, the archæologist, residing in Ellicott City, Maryland. His monograph appears among the octavo publications or 'Reports' of the United States National Museum, Smithsonian Institution, under the title: 'Pipes and Smoking Customs of the American Aborigines, based on material in the United States Museum,' 1897, pp. 351–645, and last year also appeared as a separate volume. Numerous illustrations give us an idea of the richest and most curious finds of sundry tribes, partly of stone or wood, partly of terracotta and clay, a large number of them having been found in the mounds of the Ohio and Mississippi valleys. The shape of the bowls are of all descriptions; some represent birds, heads of birds, mice and other rodents, toads, frogs, lizards, men in a recumbent, sitting or squatting posture, human hands and faces, etc. The tubular shape was widely in use in ancient America, though it looks very inconvenient to us; Mr. McGuire figures stone tubes with bone mouthpiece, sandstone tubes, pottery tube pipes, red pottery tube and bowl pipes, steatite tubular pipes, copper tubes, bone pipes and others. There are also stone urn-shaped bowls, stone bowls with thong holes, antler pipes, fossil pipes, various kinds of trade pipes, brazed iron pipes, tomahawk and monitor pipes. The feathered calumet pipe of the West looks artistic and attractive, and the vase-shaped Micmac pipe has at least the merit of curiosity.

The author has with consummate industry collected passages referring to pipes and smoking in the historians of past centuries and given his ideas about the formation of types in smoking implements. There are but few articles of Indian manufacture that will give a clearer idea of the artistic sense or genus in fashioning ruder material than pipes, although they all manifest that they originated in the stage of barbarism. Probably the oldest instance, historically traceable, is the richly dressed shaman or chief represented upon the Palenque tablet of Chiapas state, who makes use of a long tubular pipe to produce a huge cloud of smoke issuing at the wider end, and seems to enjoy the smoking intensely, to judge from his very characteristic grimaces. This bas-relief is reproduced in McGuire's publication; he thinks that the use of tobacco for snuffing was peculiar to South America, and the habit of chewing is but seldom and indistinctly referred to in any part of this western world.

A. S. G.

SCIENTIFIC NOTES AND NEWS.

The Prussian Budget, which has passed to a second reading, contains an appropriation of 7,300,000 Marks, for the purchase of lands in Berlin, on which is to be erected a building for the Academy of Sciences and the Royal Library. The value of the land is estimated at over 11,000,000 Marks, but about 3,000,000 Marks is obtained by the exchange of other property, and 1,000,000 Marks is to be appropriated next year.

At a meeting of the Royal Institution, London, on April 2d, it was announced that the managers had that day awarded the Actonial Prize of 100 guineas to Sir William Huggins, F.R.S., and Lady Huggins for their work 'An Atlas of Representative Stellar Spectra.' The special thanks of the members were returned to Mrs. West and Mrs. F. Colenso for their present of a portrait of their father, the late Sir Edward Franklin, F.R.S., professor of chemistry at the Royal Institution from 1863 to 1868.

Dr. Rudolph Amadeus Philippi the naturalist, professor in the University of Chili at Santiago, has celebrated the seventieth anniversary of his doctorate. Congratulatory addresses have been forwarded from the German Botanical Society and the Medical Faculty of the University of Berlin.

Dr. O. Burger, titular professor of the University of Göttingen, has been appointed director of the zoological division of the National Museum at Santiago and professor in the university.

Mr. John C. Hammond has been appointed assistant in the *Nautical Almanac* office, connected with the United States Naval Observatory, Washington, D. C.

Dr. William P. Wilson, director of the Philadelphia Commercial Museums, has gone to San Francisco to assist in the establishment of the Pacific Commercial Museum.

Professor Oscar Bolza, of the University of Chicago, has sailed from New York for Naples. He expects to be abroad for nine months pursuing mathematical investigations in a university town.

Professor F. Wohltmann, of Bonn, has been commissioned by the German government to proceed to Africa to make agricultural studies in the Cameroon District.

The Michigan Academy of Sciences held its annual meeting at Lansing, on March 29th and 30th. The president, Professor Jacob Reighard, gave an address on 'The Biological Sciences and the People.'

Professor Edward L. Nichols, of Cornell University, will deliver the first annual address to the honorary scientific society of Sigma Xi at Kansas University during the commencement week in June.

Professor John M. Coulter, who has recently returned to Chicago after a long stay in Washington, addressed the Botanical Club on April 10th on the present work of the Washington botanists.

Mr. M. A. Barber, associate professor of botany in the University of Kansas, has sailed for Europe. He will spend the summer in special study in bacteriology at the University of Berlin, returning for the opening of the fall term.

THE following appointments have been made by the Irish Department of Agriculture and Technical Instruction: To be Superintendent of Statistics and Intelligence branch, Mr. W. P. Coyne, M.A., Fellow of the Royal University of Ireland, professor of political economy and jurisprudence, University College, Dublin, barrister-at-law. To be Inspector in Agriculture, Mr. James Scott Gordon, B.Sc., Department of Agriculture, Edinburgh University, principal of the Cheshire County Council Agricultural and Horticultural School. To be Inspector in Industrial Branch, Mr. W. T. M'Cartney Filgate.

MR. ROGERS FIELD, an English hydraulic and drainage engineer, died at Hampstead on March 28th, at the age of 69 years. He was the inventor of an improvement in the aneroid barometer, but was best known for his improvements in methods of sanitary engineering.

M. SAMSON JORDAN, a distinguished French engineer and metallurgist, has died at the age of sixty-nine years. He had been since 1865, professor of metallurgy in the École des Arts et Manufactures. He in numerous ways promoted the advancement of the iron and steel industries in France and was the author of several valuable metallurgical treatises.

WE find in the *Auk* notices of the deaths of several members of the Ornithologists' Union. Mr. George P. Sennet died at his home at Youngstown, O., on March 18th at the age of 59 years. Though in active business he made valuable studies on the birds of Texas and the adjacent territory and his fine collection is at present in the American Museum of Natural History. W. E. Brooks has died at Mount Forest, Ontario, at the age of 70 years. He was an authority on the birds of India and his large collection is now in the British Museum. He wrote especially on the smaller warblers and the raptores. Mr. Francis C. Brown has died at Framingham, Mass., in his 70th year. In early life he was associated with Agassiz and other naturalists and made valuable observations on the habits of birds. John A. Dakin has died at Syracuse, N. Y., in his 48th year. He was a student of birds and butterflies. Mr. Foster H. Brackett died at Dorchester, Mass., aged 87 years. He had contributed notes on birds to the *Auk*.

A TELEGRAM has been received at the Harvard College Observatory from Professor Kreutz, at Kiel, stating that he has information from Professor Backlund, Director of the Observatory at Pulkowa, Russia, that from a discussion of spectrograms, Belopolsky has found the time of rotation of Venus to be short.

WE note in a recent article by Dr. K. Kishinouye, in the *Revue Internationale de Pêche et de Pisciculture* (the new Russian journal), that a Japanese marine zoological station was opened during the past summer, on the coast of the Inland sea. It is for the present located in a two-story house at Omomichi. We note also in the same article that a large coral reef has been recently discovered near the southern end of Kiu Shiu. Its size must be a large one, for more than sixty boats are fishing it actively.

STATE bacteriological institutes are being established in various parts of Russia. Among those recently founded are one at Vladivostock in Eastern Asia, and one in Merv, in Central Asia. The latter is of special importance because many epidemic diseases are thought to have their origin in Central Asia.

THE Maryland Legislature has made the following appropriations for the scientific work of the Maryland Geological Survey and the Maryland Weather service for the next two years:

Maryland Geological Survey, Geological Division, $10,000 annually.

Maryland Geological Survey, Highway Division, $10,000 annually.

Maryland Geological Survey, Topographic Division, $5,000 annually.

Maryland Weather Service, $2,000 annually.

The Survey has recently commenced the investigation of the clay products of Maryland under Professor Heinrich Ries who will prepare a volume of reports upon the clay industry of Maryland, making such physical and chemical tests of the clays as may be required to show their possibilities in various directions.

BY the will of the late John Halstead, Cooper Union, New York City, is made the residuary legatee of his estate, and will ultimately receive about $250,000.

AMONG the bills passed by the New York Legislature just before its adjournment was included an item "For the Pathological Institute, twenty thousand dollars, or so much thereof as may be necessary, no part of which shall be paid for rent." As the Pathological Institute is established in rented quarters in New York City, it is not obvious how it can continue its work without paying rent. The State commissioners in Lunacy, it is suggested, may have taken this method to stop the work of the Institute.

THE seventh annual reception and exhibition of the New York Academy of Sciences will be held at the American Museum of Natural History on April 25th and 26th. On Wednesday evening, April 25th, there will be a reception to the members of the academy and their invited guests, while on the following day the exhibition will be open in the afternoon for students and others, and in the evening there will be a reception for the members of the Scientific Alliance. The committee in charge of the exhibition consists of Professor J. F. Kemp, chairman; Professor Henry F. Osborn, Mr. Charles F. Cox, Professor Charles A. Doremus, and Professor J. J. Stevenson. The exhibition is to be divided into a number of sections, each in charge of a chairman, who is responsible for the collection of exhibits. The various chairmen and their departments are as follows: Anthropology, Professor Franz Boas; astronomy, Professor J. K. Rees; botany, Professor D. T. MacDougal; chemistry, Professor Charles E. Pellew; electricity, George F. Lever; geology and geography, Professor R. E. Dodge; metallurgy, Professor Henry M. Howe; mineralogy, Dr. L. McI. Luqueer; paleontology, Gilbert Van Ingen; physics and photography, Professor William Hallock; psychology, Dr. Edward L. Thorndike; zoology, Professor Charles L. Bristol.

THE eleventh session of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences, located at Cold Spring Harbor, Long Island, will open on Wednesday, July 4th, and continue for six weeks. The following courses are announced: by Professor C. B. Davenport, of the University of Chicago, High School Zoology and Variation and Inheritance; by Dr. D. S. Johnson, of Johns Hopkins University, Cryptogamic Botany; by Professor C. P. Sigerfoos, University of Minnesota, Invertebrate and Vertebrate Embryology; by Professor H. S. Pratt, Haverford College, Comparative Anatomy; by Professor Nelson F. Davis, Bucknell University, Bacteriology; by Dr. H. C. Cowles, University of Chicago, Elements of Ecology and Ecological Seminar; Mrs. C. B. Davenport, Microscopic Methods; Dr. Henry A. Kelly, Ethical Culture Schools, New York City, Nature Study; Messrs. S. R. Williams, and W. L. Tower, of Harvard University, and W. C. Coker, of Johns Hopkins University, assist in the various courses. The different instructors offer to assist in investigation. The fee for a single course is $20, with $5 additional for an additonal course or for the use of a microscope. Board and rooms are furnished at $6 a week by the laboratory. Further information and the annual announcement may be obtained of Professor Franklin W. Hooper, 502 Fulton Street, Brooklyn, N. Y., or Dr. C. B. Davenport, University of Chicago, Chicago, Ill.

Mrs. Sara T. D. Robinson, widow of Governor Charles Robinson, has established a Kansas University woman's table for advanced work in botany, zoology, and physiology at the Marine Biological Laboratory at Woods Holl, Mass. Miss Alberta Cory, a graduate student of botany has received the first appointment.

There will be a U. S. Civil Service examination, on May 15th, for the position of statistical field agent in the service of the Fish Commission.

Secretary Gage has asked the House of Representatives to appropriate $200,000 additional to the fund of $300,000 to prevent the introduction and spread of epidemic diseases.

THE Secretary of the Interior has been requested to inform the House of Representatives of the number of acres now included in the forest reserves belonging to land-grant railroads or other corporations at the time of the creation of such forest reserves, also the amount of lieu scrip issued therefor; also what extensions of existing reserves are in contemplation, with the amount of railroad grants in proposed reserves or extensions, and the number of acres located by forest reserve scrip.

The Cartwright lectures of the Alumni Association of the College of Physicians and Surgeons, Columbia University, for 1900, will be delivered at the New York Academy of Medicine, No. 17 West 43d Street, on the evenings of April 18, 24, and 26, 1900, at 8:30 o'clock, by Professor John G. Curtis, M.D., of Columbia University. His subject is 'The Discovery of the Nerves and of their Function.'

Arrangements have been completed for the spring course of lectures, at the New York Botanical Garden, which will be given in the lecture hall of the Museum on Saturday afternoons at 4:30 o'clock, as follows:

April 14th, 'A Glimpse at the Kingdom of Plants,' by Dr. N. L. Britton.

April 21st, 'Spring Flowers,' by Mr. Cornelius Van Brunt.

April 28th, 'Ferns,' by Professor L. M. Underwood.

May 5th, 'Climbing Plants,' by Dr. D. T. MacD ugal.

May 12th, 'Seeds and Seedlings,' by Professor Francis E. Lloyd.

May 19th, 'Summer Flowers,' by Mr. Cornelius Van Brunt.

May 26th, 'Some Tropical Relatives of the Potato,' by Professor Henry H. Rusby.

June 2d, 'The Fairy-lore of Flowers,' by Professor E. S. Burgess.

June 9th, 'Plants Concerned in the Formation of Coal,' by Dr. Arthur Hollick.

June 16th, 'Seaweeds,' by Dr. Carlton C. Curtis.

June 23d, 'The Flora of Alaska,' by Mr. Frederick V. Coville.

The lectures will be illustrated by charts, living material and lantern slides and will be non-technical. The museum building may be reached by a walk of three minutes from the Bedford Park Station of the Harlem division of the New York Central Railroad, and by a walk of five minutes from the Fordham trolley line, connecting directly with the Second and Third Avenue Elevated roads.

The Department of Archæology and Paleontology of the University of Pennsylvania announces a course of free public lectures to be illustrated by objects in the museum, to be delivered in the Widener Lecture Hall of the Museum on Wednesday afternoons at 4 p. m. as follows:

April 4th, Professor Lightner Witmer, 'Present Day Survivals of Primitive Modes of Thought and Feeling.'

April 11th, Mr. Stewart Culin, 'The Origin of Ornament.'

April 18th, Dr. A. T. Clay, 'Recent Excavations in Babylonia.'

April 25th, Dr. William N. Bates, 'Coinage of the Ancient Greeks.'

May 2d, Professor Hugh A. Clarke, 'The Genesis of Musical Instruments.'

May 9th, Dr. Simon Flexner, 'Impressions of the Philippine Islands.'

May 16th, Professor John B. McMaster, 'Household Life of Women in the Colonial Period.'

With reference to M. Joseph Bertrand, whose death we announced last week, a correspondent of the London *Times* says: Born at Paris in 1823, he was early initiated by his father, who had been trained at the Polytechnic School, into mathematical studies. At 11 years of age he passed an examination for admission into that school, but this was merely an exploit, and he did not enter the establishment till the usual age of 17, when he headed the list of candidates. On leaving the Polytechnic, he became a mine inspector, next professor at a Paris college, and afterwards professor successively at the Polytechnic, the Normal School, and the Collège de France. In 1856 he succeeded Sturm in the Academy of Sciences, and in 1874 he took the place of Eli de Beaumont as one of its secretaries. In 1884 he became the successor of Jean Baptist Dumas in the French Academy. As a writer and debater he was singularly clear, sometimes with a vein of irony. Of late years he contributed biographical and critical articles on genuine or pseudo-mathematicians to the *Revue des Deux Mondes*. His more serious works include essays on Paschal, Lavoisier, d'Alembert, and Comte, and lectures on the calculation of chances, and on electricity. His son, M. Marcel Bertrand, a mining engineer, is likewise a member of the Academy of Sciences.

THE Royal Meteorological Society celebrated its Jubilee on Tuesday and Wednesday, April 3rd and 4th. The *British Medical Journal* states that on Tuesday afternoon a meeting was held, when the President (Dr. C. Theodore Williams), addressed a large number of Fellows of the Society and delegates of other societies. He began by explaining that the late Mr. G. J. Symons, who had been elected President for the Jubilee year, had, before his fatal seizure of apoplexy, prepared an address tracing the beginning of meteorology in this country, and the history of the Society. Mr. Symons stated that the earliest observer was the Rev. William Merle, whose records, made at Driby, in Lincolnshire, from 1337 to 1344, were still preserved in the Bodleian Library. After referring to Robert Boyle and Dr. Plot, Mr. Symons pointed out that Sir Christopher Wren, the architect of St. Paul's was the inventor of the first recording rain gauge. An English Meteorological Society had been founded in 1823, but did little work. Another society was founded in 1836, but did not take any part in the formation of the present society, which was founded on April 3, 1850, at the house of the late Dr. Lee, F.R.S., of Aylesbury, under the name of the British Meteorological Society. In 1866 a Royal Charter was obtained, and the Society assumed its present name. Mr. Symons urged that the Government, which provided a home for some of the richer societies at Burlington House, ought to build a proper centre for the smaller societies, and his address concluded with a sketch of the work done by the Royal Meteorological Society. Dr. Theodore Williams, after a short appreciation of the character and work of the late Mr. Symons, gave account of the scientific work which is now being carried on by the Society. At the conclusion of Dr. Williams's remarks each of the delegates at tending the meeting was presented with a medal struck in honor of the occasion. In the evening a *conversazione* was held, and on Wednesday morning a visit was paid to Greenwich Observatory. In the evening a dinner was held over which Dr. Theodore Williams presided. Mr. W. N. Shaw, the Secretary of the Meteorological Council, who gave the toast of 'The Royal Meteorological Society,' enumerated some of the phenomena which still awaited explanation and insisted on the necessity of co-operation, both among meteorologists themselves and between them and workers in other sciences. The toast having been suitably acknowledged by the President, Mr. Bayard gave that of 'The Delegates from other Societies,' for which Professor Silvanus Thompson responded.

Nature in commenting editorially on the discussion before the American Society of Naturalists, on 'The position that universities should take in regard to the investigation,' published in this JOURNAL, compares unfavorably the work of English Universities with those in the United States and in Germany. The article concludes as follows: It is needless to say that, like the American universities, the universities of the continent, and in especial those of Germany, are conspicuous for the extent to which they encourage research by their funds and by their arrangements. The historian of the future, who is to trace the vast progress made in recent years by Germany in power, wealth, commerce, the arts and industries, without doubt will notice the part played by her many universities in this momentous change. A single article in the pages of a scientific journal is not a suitable vehicle for any exact examination of the relative advances made by England and other countries in recent times. But, until matters have been put right, every opportunity is convenient to insist that the universities of Britain do not encourage research sufficiently, and that, in particular, her richest university habitually and systematically despises research in its general arrangements, in the allocation of its endowments, and in the distribution of its revenues. Moreover, it is especially unfortunate that not only is the amount of consideration given to research minute, but is diminishing. A single example is more convincing than a multitude of general statements, and an appropriate instance lies unfortunately ready to hand in the preface to the last volume of 'Linacre Reports,' recently issued by Professor Ray Lankester. The late Linacre Professor and present keeper of the British Museum of Natural History, in a preface addressed to the vice-chancellor of the University of Oxford, deplores the attitude of the Oxford colleges to the natural sciences. "The college endowments," he states, and every one with knowledge of the matter is able to corroborate, "are now more largely than ever employed in maintaining a tutorial system, which is in itself of small value—if not positively injurious—and necessarily in complete antagonism to the development of the method of study, and to the wide range of subjects studied, which distinguish everywhere but in Oxford the university from the preparatory school." Professor Lankester believes that the natural sciences, the subjects particularly associated with research as a means of training and as a source of directive knowledge, should be supported by not less than two-thirds of the endowments at the disposal of these colleges. Oxford, no doubt, is an extreme example of the general failure of British universities to respond adequately to what everywhere but in England is regarded as the first duty of a university; but there is urgent need for inquiry into and redress of the conditions which have brought about the present state of affairs, and those institutions which have taken a larger view of their duties will be the first to approve a strong statement of the existing failure.

UNIVERSITY AND EDUCATIONAL NEWS.

As the daily papers have announced, the University of Chicago has secured the $2,000,000 needed to meet the requirements of Mr. Rockefeller's gift of an equal amount. At the recent convocation of the University, President Harper gave some details in regard to the gifts received since January 1st. They have come from more than 200 different persons and 90 per cent. of them were unsolicited. The largest items appear to be the Gurley paleontological collection, $30,000 from Mrs. Delia Gallup and, given anonymously, $60,000 for a commons, $50,000 and $25,000 for a students' club-house, $20,000 towards a women's hall, and $30,000 with specific use to be designated later. President Harper stated that the total assets of the University are now not far from $11,000,000.

BY the will of Mrs. Mary J. Furman, Vanderbilt University receives about $250,000.

BARNARD COLLEGE, Columbia University, has received a gift of $100,000 subject to certain annuities.

BY the will of ths late Arthur D. McLellan, Brown University may, under certain conditions, receive from $8000 to $33,000.

THE widow of the late Professor H. Fol has given to the University of Lausanne his collection of scientific apparatus and histological preparations.

HARVARD UNIVERSITY has undertaken to guarantee $70,000 to entertain 1450 Cuban teachers during their stay at the Summer School in accordance with the arrangements made by Mr. Alexis E. Frye, Superintendent of Schools at Cuba. Free tuition is provided by the University.

IN view of the fact that a case of small-pox has been reported in each of two of our leading universities, it may be well to state that during the first week in April the United States Marine Hospital Service reports only one case of small-pox throughout all the middle and New England States. There is, however, a slight epidemic of small-pox at New Orleans.

THE University of Pennsylvania has made some changes in the regulations under which candidates are advanced to the higher degrees. Hereafter the theses for the doctorate must be printed and it is expected that in the case of longer theses the University will contribute $50 towards the cost. The examinations will be written and may be passed at such time as the candidate is prepared. Instead of appearing before the dean and a committee of three examiners for an oral examination as at present, the candidate will be presented to the entire Faculty of Philosophy in formal session, with the Provost in the chair. A representative of the Group Committee with whom the candidate has taken his major subject will spread before the Faculty the candidate's credentials. These will comprise a brief sketch of his academic life, a more detailed account of the scope and character of his work as a graduate student, of the examinations which he has passed, and more particularly of the scope and significance of his thesis. His presenter will then formally recommend him to the Faculty on behalf of the Group Committee as a candidate for the degree of Doctor of Philosophy. After hearing the candidate's credentials read, any member of the Faculty may make further inquiries of the candidate or of the presenter; and a formal vote will then be taken upon the recommendation. The regulations for the Master's degree will differ from those above outlined only (1) in the amount of work required; (2) in the fact that the dean will act as presenter; (3) and that no reference will be made to a thesis.

It will be remembered that the doctors' theses in the German universities were written in Latin till about thirty years ago. Another step toward the abolition of Latin as the official language of the universities is now being taken as it is planned to use German in doctor's diplomas and other official documents.

The enrollment of students in the University of Kansas is now 1130. This number is divided among the various schools as follows: Arts, 546; Engineering, 165; Law, 162; Pharmacy, 85; Medicine, 33; Fine Arts, 91; Graduate School, 48.

The position of Demonstrator of Histology and Embryology at the Harvard Medical School is vacant. The salary for the ensuing year will be not less than $750. The holder of this position is expected to be generally responsible for the laboratory class work, which will require about half his time throughout the year. The remainder of his time is to be given to original research. Applications should be accompained by a statement of previous experience in teaching and investigation, and may be addressed to Professor Charles S. Minot, Harvard Medical School, Boston, Mass.

Dr. E. Benjamin Andrews, superintendent of the public schools of Chicago, has declined the chancellorship of the University of Nebraska.

Dr. C. M. Bakewell, of Bryn Mawr College, has been called to a professorship of philosophy in the University of California and will be succeeded at Bryn Mawr by Dr. David Irons, of Cornell University, who will have the title of 'Associate.'

Dr. W. E. Castle has been appointed instructor of zoology in Harvard University.

The following promotions and new appointments have been made at the University of Chicago:

L. W. Jones, Assistant, to an Associateship in Chemistry.

H. G. Gale, Assistant, to an Associateship in Physics.

Stuart Weller, Associate, to an Instructorship in Geology.

F. R. Moulton, Associate, to an Instructorship in Astronomy.

H. E. Slaught, Instructor, to an Assistant Professorship in Collegiate Mathematics.

Ella F. Young, Associate Professorial Lecturer, to an Associate Professorship in Pedagogy.

E. O. Jordan, Assistant Professor, to an Associate Professorship in Bacteriology.

W. I. Thomas, Assistant Professor, to an Associate Professorship in Sociology.

George E. Vincent, Assistant Professor, to an Associate Professorship in Sociology.

James H. Tufts, Associate Professor, to a Professorship in Philosophy.

Jacques Loeb, Associate Professor, to a Professorship in Physiology.

S. W. Straton, Associate Professor, to a Professorship in Physics.

John E. Webb, Graduate Student, to an Academy Assistantship in Physiography and Biology.

Howard Emlyn Davies, Fellow, to an Assistantship in Bacteriology.

George W. Ritchie, to the Superintendency of Instrument Construction at the Yerkes Observatory.

W. F. E. Gurley, to an Associate Curatorship in Paleontology.

Frank R. Lillie, Professor of Zoology in Vassar College, to an Assistant Professorship in Zoology.

Leonard E. Dickson, Associate Professor of Mathematics in the University of Texas, to an Assistant Professorship in Mathematics.

Alexander Smith, Associate Professor of Chemistry, to a Deanship in the Junior Colleges.

C R. Barnes, Professor of Botany, to a Deanship in the Colleges.

Llewellys F. Barker, M.D., Professor of Anatomy in the Johns Hopkins University, to a Professorship in Anatomy and the Headship of the Department.

Dr. Gattermann, of the University of Freiburg, i. B., has been promoted to a full professorship, and has been made director of the Chemical Institute.

Mr. W. B. Hardy, of Gonville and Caius College, Cambridge University, has been appointed senior demonstrator in physiology.

SCIENCE

Friday, April 27, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*LIQUID HYDROGEN.**

From the year 1878, when the experiments of Cailletet and Pictet were attracting the attention of the scientific world, it became a common habit in text-books to speak of all the permanent gases, without any qualification, as having been liquefied, whereas these experimentalists, by the production of an instantaneous mist in a glass tube of small bore, or a transitory liquid jet in a gas expanding under high compression into air, had only adduced evidence that sooner or later the static liquid form of all the known gases would be attained. Neither Pictet nor Cailletet in their experiments ever succeeded in collecting any of the permanent gases in that liquid form for scientific examination. Yet we meet continually in scientific literature with expressions which lead one to believe that they did. For instance, the following extract from the 'Proceedings' of the Royal Society, 1878, illustrates this point very well: "This award (Davy Medal) is made to these distinguished men (Cailletet and Pictet) for having independently and contemporaneously liquefied the whole of the gases hitherto called permanent." Many other quotations of the same kind may be made. As a matter of fact six years elapsed, during which active investigation in this department was being prose-

* Lecture before the Royal Institution of Great Britain.

cuted, before Wroblewski and Olszewski succeeded in obtaining oxygen as a static liquid, and to collect liquid hydrogen, which is a much more difficult problem, has taken just twenty years from the date of the Pictet and Cailletet experiments.

Wroblewski made the first conclusive experiment on the liquefaction of hydrogen in January, 1884. He found that the gas cooled in a capillary glass tube to the boiling point of oxygen, and expanded quickly from 100 to 1 atmosphere, showed the same appearance of sudden ebullition lasting for a fraction of a second, as Cailletet had seen in his early oxygen experiments. No sooner had the announcement been made, than Olszewski confirmed the result by expanding hydrogen from 190 atmospheres, previously cooled to the temperature given by liquid oxygen and nitrogen evaporating under diminished pressure. Olszewski, however, declared in 1884 that he saw colorless drops, and by partial expansion to 40 atmospheres, the liquid hydrogen was seen by him running down the tube. Wroblewski could not confirm Olszewski's results, his hydrogen being always obtained in the form of what he called a 'liquide dynamique,' or the appearance of an instantaneous froth. Olszewski himself seven years later repeated his experiments of 1884 on a larger scale, confirming Wroblewski's results, thereby proving that the so-called liquid hydrogen of the earlier experiments must have been due to some impurity. The following extract from Wroblewski's paper states very clearly the results of his work on Hydrogen:

"L'hydrogène soumis à la pression de 180 atm. jusqu'à 190 atm., refroidi par l'azote bouillant dans la vide (à la température de sa solidification) et détendu brusquement sous la pression atmosphérique présente une mousse bien visible. De la couleur grise de cette mousse, où l'œil ne peut distinguer des gouttelettes incolores, on ne peut pas encore deviner quelle apparence aurait l'hydrogène à l'état de liquide statique et l'on est encore moins autorisé à préciser s'il a ou non une apparence métallique. J'ai pu placer dans cette mousse ma pile thermoélectrique, et j'ai obtenu suivant les pressions employées des températures de −208° jusqu'à −211° C. Je ne peux pas encore dire dans quelle relation se trouvent ces nombres avec la température réelle de la mousse ou avec la température d'ébullition de l'hydrogène sous la pression atmosphérique, puisque je n'ai pas encore la certitude que la faible durée de ce phénomène ait permis à la pile de se refroidir complètement. Néanmoins, je crois aujourd'hui de mon devoir de publier ces résultats, afin de préciser l'état actuel de la question de la liquéfaction de l'hydrogène."*

It is well to note that the lowest thermo-electric temperature recorded by Wroblewski during the adiabatic expansion of the hydrogen (namely, −211°) is really equivalent to a much lower temperature on the gas-thermometer scale. The most probable value is −230°, and this must be regarded as the highest temperature of the liquid state, or the critical point of hydrogen, according to his observations. In a posthumous paper of Wroblewski's on 'The Compression of Hydrogen,' published in 1889, an account appears of further attempts which he had made to liquefy hydrogen. The gas compressed to 110 atmospheres, was cooled by means of liquid nitrogen under exhaustion to −213.8°. By suddenly reducing the pressure, as low a temperature as −223° on his scale was recorded, but without any signs of liquefaction. This expansion gives a theoretical temperature of about 15° absolute in the gas particles. The above methods having failed to produce static hydrogen, Wroblewski suggested that the result might be attained by the use of hydrogen gas as a cooling agent. From this time until his death in the year

* Compt. Rend., 1885, 100, 981.

1888, Wroblewski devoted his time to a laborious research on the isothermals of hydrogen at low temperatures. The data thus arrived at enabled him, by the use of Van der Waal's formulæ, to calculate the critical constants, and also the boiling point of liquid hydrogen.

Olszewski returned to the subject in 1891, repeating and correcting his old experiments of 1884, which Wroblewski had failed to confirm, using now a glass tube 7 mm. in diameter instead of one of 2 mm. as in the early trials. He says: "On repeating my former experiments, I had no hope of obtaining a lower temperature by means of any cooling agent, but I hoped that the expansion of hydrogen would be more efficacious, on account of the larger scale on which the experiments were made." The results of these experiments Olszewski describes as follows: "The phenomenon of hydrogen ebullition, which was then observed, was much more marked and much longer than during my former investigations in the same direction. But even then I could not perceive any meniscus of liquid hydrogen." Further, "*The reason for which it has not hitherto been possible to liquefy hydrogen in a static state, is that there exists no gas having a density between those of hydrogen and of nitrogen, and which might be for instance* 7–10 (H = 1). Such a gas could be liquefied by means of liquid oxygen or air as cooling agent, and be afterwards used as a frigorific menstruum in the liquefaction of hydrogen."

Professor Olszewski, in 1895, determined the temperature reached in the momentary adiabatic expansion of hydrogen at low temperatures, just as Wroblewski had done in 1885, only he employed a platinum-resistance thermometer instead of a thermo-junction. For this purpose he used a small steel bottle of 20 or 30 cc. capacity, containing a platinum-resistance thermometer; in this way the temperatures registered were regarded as those of the critical and boiling points of liquid hydrogen, a substance which could not be seen under the circumstances and was only assumed to exist for a second or two during the expansion of the gaseous hydrogen in the small steel bottle.

The results arrived at by Wroblewski and Olszewski are given in the following table, and it will be shown later on that Wroblewski's constants are nearest the truth.

	Wroblewski, 1885.	Olszewski, 1895.
Critical temperature	—240°	—234°
Boiling point	—250°	—243°
Critical pressure	13 atm.	20 atm.

The accuracy of Wroblewski's deductions regarding the chief constants of liquid hydrogen following from a study of the isothermals of the gas is a signal triumph for the theory of Van der Waals and a monument to the genius of the Cracow physicist. From these results we may safely infer that supposing a gas is hereafter discovered in small quantity four times more volatile than liquid hydrogen, having a boiling point of about 5° absolute, and therefore incapable of direct liquefaction by the use of liquid hydrogen, yet by a study of its isothermals we shall succeed in finding out its most important liquid constants, although the isolation of the real liquid may for the time be impossible.

In a paper published in the *Philosophical Magazine*, September, 1884, 'On the Liquefaction of Oxygen and the Critical Volumes of Fluids,' the suggestion was made that the critical pressure of hydrogen was wrong, and that instead of being 99 atmospheres (as deduced by Sarrau from Amagat's isothermals) the gas had probably an abnormally low value for this constant. This view was substantially confirmed by Wroblewski finding the critical pressure of 13.3 atmospheres, or about one-fourth of that of oxygen. The *Chemical News*, September 7, 1894, contains an account of the stage the author's hydrogen experiments had reached at that date. The object was to collect liquid hydrogen at its boiling point, in an open vacuum vessel, which is a much more difficult problem than seeing it in a glass tube under pressure and at a higher temperature. In order to raise the critical point of hydrogen to about — 210°, from 2 to 5 per cent. of nitrogen or air was mixed with it. *This is simply making an artificial gas containing a large proportion of hydrogen which is capable of liquefaction by the use of liquid air.* The results are summed up in the following extract from the paper: "One thing can, however, be proved by the use of the gaseous mixture of hydrogen and nitrogen, namely that by subjecting it to a high compression at a temperature of — 200° and expanding the resulting liquid into air, a much lower temperature than anything that has been recorded up to the present time can be reached. This is proved by the fact that such a mixed gas gives, under the conditions, a paste or jelly of solid nitrogen, evidently giving off hydrogen, because the gas coming off burns fiercely. Even when hydrogen containing only some 2 to 5 per cent. of air is similarly treated, the result is a white solid matter (solid air) along with a clear liquid of low density, which is so exceedingly volatile that no known device for collecting it has been successful." This was in all probability the first liquid hydrogen obtained, and the method is applicable to other difficultly liquefactible gases.

Continuing the investigations during the winter of 1894, and the greater part of 1895, the author read a paper before the Chemical Society in December of that year entitled, 'The Liquefaction of Air and Research at Low Temperatures,'* in which occasion was taken to describe for the first time the mode of production and use of a Liquid Hydrogen Jet. At the same meeting Professor William Ramsay made an announcement of a sensational character, which amounted to stating that my hydrogen results had been not only anticipated but bettered. The statement made to the Society by Professor Ramsay, reads as follows: "*Professor Olszewski had succeeded in liquefying hydrogen, and from unpublished information received from Cracow, he (Ramsay) was able to state that a fair amount of liquid had been obtained, not as a froth, but in a state of quiet ebullition, by surrounding a tube containing compressed hydrogen by another tube also containing compressed hydrogen at the temperature of oxygen boiling at a very low pressure. On allowing the hydrogen in the middle jacket suddenly to expand, the hydrogen in the innermost tube liquefied, and was seen to have a meniscus. Its critical point and its boiling point, under atmospheric pressure, were determined by means of a resistance thermometer.*" *

This announcement of Professor Ramsay's had from its very specific and detailed experimental character the merit of the appearance of being genuine, although it was never substantiated, either by the production of the Cracow document, or by any subsequent publication of such important results by Professor Olszewski himself. My observation at the time on Professor Ramsay's communication was that quotations had been made in my paper from the most recent publications of Professor Olszewski in which he made *no mention of getting 'Static Hydrogen or of seeing a meniscus' or of getting what Professor Ramsay alleged 'a fair amount of liquid, not as a froth, but in state of quiet ebullition.'* To achieve such a result would require a very different scale of experiment from anything Professor Olszewski had so far described. Naturally an early corroboration of the startling statement

*'Proceedings' of the Chemical Society, No. 158, 1895.

*'Proceedings' of the Chemical Society, No. 195, 1897–1898.

made by Professor Ramsay as to this alleged anticipation was expected, but strange to say Professor Olszewski published no confirmations of the experiments detailed by Professor Ramsay in scientific journals of date immediately preceding my paper or during the following years 1896, 1897 or up to May, 1898. The moment the announcement was made by me to the Royal Society in May, 1898 that, after years of labor, hydrogen had at last been obtained as a static liquid, Professor Ramsay repeated the story to the Royal Society that Olszewski had anticipated my results (basing the assertion solely on the contents of the old letter received some two and a half years before), in spite of the fact that during the interval he, Professor Ramsay, must have known that Professor Olszewski had never corroborated in any publication either the form of the experiments he had so minutely described or the results which were said to follow. Challenged by me at the Royal Society Meeting on May 12, 1898, to produce Olszewski's letter of 1895, he did not do so, but at the next meeting of the Society, Professor Ramsay read a letter he had received during the interval from Professor Olszewski, denying that he had ever stated that he had succeeded in producing static liquid hydrogen. This oral communication of the contents of the new Olszewski letter (of which it is to be regretted there is no record in the published proceedings of the Royal Society) is the only kind of retraction Professor Ramsay has thought fit to make of his published misstatements of facts. No satisfactory explanation has yet been given by Professor Ramsay of his twice repeated categorical statements made before scientific bodies of the results of experiments which, in fact, had never been made by their alleged author. The publicity that has been given to this controversy makes it imperative that the matter should not be passed over, but once for all recorded.

The report of a Friday Evening Discourse on 'New Researches on Liquid Air,'* contains a drawing of the apparatus employed for the production of a jet of hydrogen containing visible liquid. This is reproduced

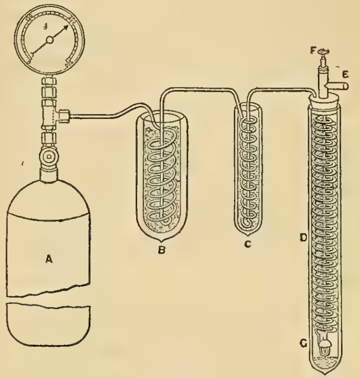

Fig. 1.

in Fig. 1. *A* represents one of the hydrogen cylinders; *B* and *C*, vacuum vessels containing carbolic acid under exhaustion and liquid air respectively; *D* is the coil, *G* the pin-hole nozzle, and *F* the valve. By means of this hydrogen jet, liquid air can be quickly transformed into a hard solid. It was shown that such a jet could be used to cool bodies below the temperature that it is possible to reach by the use of liquid air, but all attempts to collect the liquid hydrogen from the jet in vacuum vessels failed. No other investigator improved on my results,† or has indeed touched the subject during the last three years. The type of apparatus used in these experiments worked well, so it was resolved to construct a much larger liquid-air plant, and to combine with it circuits and arrangements for the liquefaction of hy-

* 'Proceedings' of the Royal Institution, 1896.

† 'Proceedings of the Chemical Society' (No. 158), 1895.

drogen. This apparatus took a year to build, and many months have been occupied in the testing and preliminary trials. The many failures and defects need not be detailed.

On May 10, 1898, starting with hydrogen cooled to —205°, and under a pressure of 180 atmospheres, escaping continuously from the nozzle of a coil of pipe at the rate of about 10 to 15 cubic feet per minute, in a vacuum vessel doubly silvered and of special construction, all surrounded with a space kept below —200°, liquid hydrogen commenced to drop from this vacuum vessel into another doubly isolated by being surrounded with a third vacuum vessel. In about five minutes, 20 c.c. of liquid hydrogen were collected, when the hydrogen jet froze up, from the accumulation of air in the pipes frozen out from the impure hydrogen. The yield of liquid was about one per cent. of the gas. The hydrogen in the liquid condition is clear and colorless, showing no absorption spectrum, and the meniscus is as well defined as in the case of liquid air. The liquid must have a relatively high refractive index and dispersion, and the density appears at first sight to be in excess of the theoretical density, namely 0.18 to 0.12, which we deduce respectively from the atomic volume of organic compounds, and the limiting density found by Amagat for hydrogen gas under infinite compression. A preliminary attempt, however, to weigh a small glass bulb in the liquid made the density only about 0.08, or half the theoretical. My old experiments on the density of hydrogen in palladium gave a value for the combined element of 0.62. Not having arrangements at hand to determine the boiling point other than a thermo-junction which gave entirely fallacious results, experiments were made to prove the excessively low temperature of the boiling fluid. In the first place if a long piece of glass tubing, sealed at one end and open to the air at the other, is cooled by immersing the closed end in the liquid hydrogen, the tube immediately fills where it is cooled with solid air. A small glass tube filled with liquid oxygen when cooled in liquid hydrogen is transformed into a bluish white solid. This is a proof that the boiling point of hydrogen is much lower than any temperature previously reached by the use of liquid nitrogen evaporating *in vacuo*, seeing oxygen always remains liquid under such conditions. A first trial of putting liquid hydrogen under exhaustion gave no appearance of transition into the solid state. When the vacuum tube containing liquid hydrogen is immersed in liquid air so that the external wall of the vacuum vessel is maintained at about —190°, the hydrogen is found to evaporate at a rate not far removed from that of liquid air from a similar vacuum vessel under the ordinary conditions of temperature. This leads me to the conclusion that, with proper isolation, it will be possible to manipulate liquid hydrogen as easily as liquid air.

The boilng point of liquid hydrogen at atmospheric pressure in the first instance was determined by a *platinum-resistance thermometer*. This was constructed of pure metal and had a resistance of 5.3 ohms at 0° C., which fell to about 0.1 ohm when the thermometer was immersed in liquid hydrogen. The reduction of this resistance to normal air thermometer degrees gave the boiling points —238.2° and —238.9° respectively by two extrapolation methods, and —237° by a Dickson formula.* The boiling point of the liquid seems therefore to be —238° C. or 35° absolute, and is thus about 5° higher than that obtained by Olszewski by the adiabatic expansion of the compressed gas, and about 8° higher than that deduced by Wroblewski from Van der Waal's equation. From these results it may be inferred that the critical point of hydrogen is about 50° absolute,

* See *Phil. Mag.*, 45, 525, 1898.

and that the critical pressure will probably not exceed 15 atmospheres.

If we assume the resistance reduced to zero, then the temperature registered by the electric thermometer ought to be −244° C. At the boiling point of hydrogen, registered by the electric-resistance thermometer, if the law correlating resistance and temperature can be pressed to its limits, a lowering of the boiling point of hydrogen by 5° or 6° C., would therefore produce a condition of affairs in which the platinum would have no resistance, or would become a perfect conductor. Now we have every reason to believe that hydrogen, like other liquids, will boil at a lower temperature the lower the pressure under which it is volatilized. The question arises, how much lowering of the temperature can we practically anticipate? For this purpose we have the *boiling point given by the hydrogen gas thermometer*, and critical data available, from which we can calculate an approximate vapor pressure formula, accepting 22° absolute as about the boiling point, 33° absolute as the critical temperature, and 15.4 atmospheres as the critical pressure; then, as a first approximation—

$$\log. p = 6.410 - \frac{77.62}{T} \text{mm.} \quad . \; . \; . \quad (1)$$

If, instead of using the critical pressure in the calculation, we assume the molecular latent heat of hydrogen to be proportional to the absolute boiling point, then, from a comparison with an expression of the same kind, which gives accurate results for oxygen tensions below one atmosphere, we can derive another expression for hydrogen vapor pressures, which ought to be applicable to boiling points under reduced pressure.

The resulting formula is—

$$\log. p = 7.0808 - \frac{88}{T} \text{mm.} \quad . \; . \; . \quad (2)$$

Now formula (1) gives a boiling point of 14.2° absolute under a pressure of 25 mm., whereas the second equation (2) gives for the same pressure 15.4° absolute. As the absolute boiling point under atmospheric pressure is about 22°, both expressions lead to the conclusion that ebullition under 25 mm. pressure ought to reduce the boiling point some 7° C. For some time experiments have been in progress with the object of determining the temperature of hydrogen boiling under about 25 mm. pressure, by the use of the platinum thermometer; but the difficulties encountered have been great, and repeated failures very exasperating. The troubles arise from the conduction of heat by the leads; the small latent heat of hydrogen, volume for volume, as compared with liquid air; the inefficiency of heat isolation; and the strain on the thermometer, brought about by solid air freezing on it and distorting the coil of wire. In many experiments, the result has been that all the liquid hydrogen has evaporated

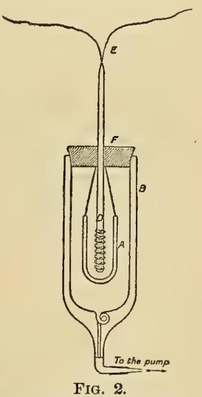

FIG. 2.

before the pressure was reduced to 25 mm., or the thermometer was left imperfectly covered. The apparatus employed will be understood from Fig. 2. The liquid hydrogen collected in the vacuum vessel *A* was suspended in a larger vessel of the same kind, *B*, which is so constructed that a spiral tube joins the inner and outer test-tubes of which *B* is made, thereby making an opening into the interior at *C*. The resistance thermometer *D* and leads *E* pass through a rubber cork, *F*, and the exhaustion takes place through *C*. In this way the cold vapors are drawn over the outside of the hydrogen vacuum vessel, and this helps to isolate the liquid from the convective currents of gas. To effect proper isolation, the whole apparatus ought to be immersed in liquid air under exhaustion. Arrangements of this kind add to the complication, so in the first instance the liquid was used as described. The liquid hydrogen evaporated quietly and steadily under a diminished pressure of about 25 mm. Naturally the liquid does not last long, so the resistance has to be taken quickly. Just before the reduction of pressure began, the resistance of the thermometer was 0.131 ohm. This result compares favorably with the former observation on the boiling point, which gave a resistance of 0.129 ohm. On reducing the pressure, the resistance diminished to 0.114 ohm, and kept steady for some time. The lowest reading of resistance was 0.112 ohm. This value corresponds to −2.391° C., or only one degree lower on its own scale, than the boiling point at atmospheric pressure, whereas the temperature ought to have been reduced at least 5°, under the assumed exhaustion, according to the gas thermometer scale. The position of the observation on the curve of the relation of temperature and resistance for No. 7 thermometer is shown on the accompanying diagram (Fig. 3). As a matter of fact, however, this platinum thermometer was, when placed in liquid hydrogen, cooled at starting below its own temperature of perfect conductivity, so that no exhaustion was needed to bring it to this point. The question arises then as to what is the explanation of this result? Has the platinum resistance thermometer arrived at a limiting resistance about the boiling point of hydrogen, so that at a lower

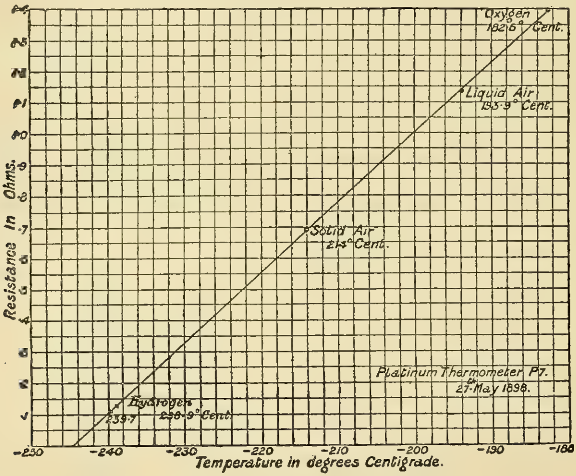

FIG. 3.

temperature its changes in resistance become relatively small—the curve having become practically asymptotic to the axis of temperature? That is the most probable supposition, and it further explains the fact that the temperature of boiling hydrogen obtained by the linear extrapolation of the resistance temperature results in values that are not low enough.

As the molecular latent heats of liquids are proportional to their absolute boiling points, the latent heat of liquid hydrogen will be about two-fifths that of liquid oxygen. It will be shown later, however, that we can reach from 14° to 15° absolute by the evaporation of liquid hydrogen under exhaustion. From analogy, it is probable that the practicable lowering of temperature to be obtained by evaporating liquid hydrogen under pressures of a few mm., cannot amount to more than 10° to 12° C., and it may be said with certainty that, assuming the boiling point 35° absolute to be correct, no means are at present known for approaching nearer than 20° to 25° to the absolute zero of temperature. The true boiling point is in reality about — 252° C., in terms *of the gas-thermometer scale*, and the latent heat of the liquid is, therefore, about two-ninths that of an equal volume of oxygen, or one-fourth that of liquid nitrogen. The platinum-resistance thermometer had a zero point of — 263.2 platinum degrees, and when immersed in boiling liquid hydrogen, indicated a temperature of — 256.8° on the same scale, or 6.4 platinum degrees from the point at which the metal would theoretically become a perfect conductor. The effect of cooling platinum from the boiling point of liquid oxygen to that of liquid hydrogen is to diminish its resistance to one-eleventh.

The difficulties in liquefying hydrogen caused by the presence of air in the gas have been referred to,* and later experiments had for their object the removal of this fruitful source of trouble. This is by no means an easy task, as quantities amounting to only a fraction of one per cent. accumulate in the solid state, and eventually choke the nozzle of the apparatus, necessitating the abandonment of the operation.

* 'Proceedings,' 1898, 14, 130.

Later experiments enabled me to procure a larger supply of liquid hydrogen with which the determination of certain physical constants has been continued. The first observations made with a pure platinum-resistance thermometer had given —238° as the boiling point. A new thermometer, constructed of platinum from a different source, gave practically the same value. As these results might be affected by some constant error, the determination was checked by employing a thermometer constructed from an alloy of rhodium and platinum, containing 10 per cent. of the former. Alloys had been shown by Professor Fleming and the author to differ from pure metals in showing no sign of becoming perfect conductors at the absolute zero of temperature, and a study of the rhodium-platinum alloy had shown that the change in conductivity produced by cooling from 0° to the boiling point of liquid air is regular and may be represented by a straight line. As determined by the rhodium-platinum thermometer, the boiling point of hydrogen was found to be —246° or some 8° lower than the platinum thermometer gave. Two ways of explaining the discrepancy between the two values suggested themselves. Pure platinum, although its resistance may be represented by a straight line almost down to the solidifying point of air, shows signs of a departure from regularity at about this point, and the curve may become asymptotic at lower temperatures. On the other hand, the resistance of the rhodium-platinum alloy diminishes less rapidly at these lower temperatures and is much higher than that of pure platinum under similar conditions. It follows that its resistance curve, in all probability, deviates less from a straight line than is the case with platinum. Either cause would explain the differences observed, but the lower boiling point (−246° or 27° absolute) seemed to be the more probable as it agreed very fairly with the value for the boiling point calculated by the author from Wroblewski's results. As the use of other pure metals or alloys was not likely to lead to more satisfactory results, the problem had to be attacked in a different way, namely, by means of an 'air' thermometer containing hydrogen under diminished pressure.

A first attempt has been made at determining the boiling-point by a constant-volume hydrogen thermometer, working under diminished pressure. This thermometer, which gave the boiling point of oxygen as 90.5° absolute or −182.5°, gave for hydrogen 21° absolute or −252°. The three determinations that have been made are then as follows: (1) pure platinum resistance thermometer, 35° absolute; (2) rhodium-platinum resistance thermometer 27° absolute; (3) hydrogen thermometer, 21° absolute. From this it appears that the boiling point of hydrogen is really lower than was anticipated, and must range between 20° and 22° absolute. Further experiments will be made with thermometers filled with hydrogen prepared from different sources. A hydrogen thermometer filled with the gas obtained from the evaporation of the liquid hydrogen itself must be employed.

The approximate density of liquid hydrogen at its boiling point was found by measuring the volume of the gas obtained by evaporating 10 cc. of the liquid, and is slightly less than 0.07, or about one-sixth that of liquid marsh-gas, which is the lightest liquid known. It is remarkable that, with so low a density, liquid hydrogen is so easily seen, has so well defined a meniscus, and can be so readily collected and manipulated in vacuum vessels. As hydrogen occluded in palladium has a density of 0.62, it follows that it must be associated with the metal in some other state than that of liquefaction.

The atomic volume of liquid hydrogen at its boiling point is about 14.3, the atomic volumes of liquid oxygen and nitrogen being 13.7 and 16.6 respectively at their boiling points. The weight of a litre of hydrogen gas at the boiling point of the liquid is about the same as that of air, at the ordinary temperature. The ratio of the density of the hydrogen gas at the boiling point to that of the liquid is approximately 1:60, as compared with a ratio of 1:255 in the case of oxygen under similar conditions.

The specific heat of hydrogen in the gaseous state and in hydrogenized palladium is 3.4, but may very probably be 6.4 in the liquid substance. Such a liquid would be unique in its properties; but as the volume of one gramme of liquid hydrogen is about 14–15 c.c., the specific heat per unit volume must be nearly 0.5, which is about that of liquid air. It is highly probable, therefore, that the remarkable properties of liquid hydrogen predicted by theory will prove to be less astonishing when they are compared with those of liquid air, volume for volume, at corresponding temperatures.

With hydrogen as a cooling agent we shall get to from 13° to 15° of the zero of absolute temperature, and its use will open up an entirely new field of scientific inquiry. Even so great a man as James Clerk Maxwell had doubts as to the possibility of ever liquefying hydrogen.* He says: "Similar phenomena occur in all the liquefiable gases. In other gases we are able to trace the existence of attractive force at ordinary pressures, though the compression has not yet been carried so far as to show any repulsive force. In hydrogen the repulsive force seems to prevail even at ordinary

* See Scientific Papers, 2, 412.

pressures. This gas has never been liquefied, and it is probable that it never will be liquefied, as the attractive force is so weak." In concluding his lectures on the non-metallic elements delivered at the Royal Institution in 1852, and published the following year, Faraday said:* "There is reason to believe we should derive much information as to the intimate nature of these non-metallic elements, if we could succeed in obtaining hydrogen and nitrogen in the liquid and solid form. Many gases have been liquefied: the carbonic acid gas has been solidified, but hydrogen and nitrogen have resisted all our efforts of the kind. Hydrogen in many of its relations acts as though it were a metal; could it be obtained in a liquid or a solid condition, the doubt might be settled. This great problem, however, has yet to be solved, nor should we look with hopelessness on this solution when we reflect with wonder—and as I do almost with fear and trembling—on the powers of investigating the hidden qualities of these elements—of questioning them, making them disclose their secrets and tell their tales—given by the Almighty to man."

Faraday's expressed faith in the potentialities of experimental inquiry in 1852 has been justified forty-six years afterwards by the production of liquid hydrogen in the very laboratory in which all his epoch-making researches were executed. The 'doubt' has now been settled; hydrogen does not possess in the liquid state the characteristics of a metal. No one can predict the properties of matter near the zero of temperature. Faraday liquefied chlorine in the year 1823. Sixty years afterwards Wroblewski and Olszewski produced liquid air, and now, after a fifteen years' interval, the last of the old permanent gases, hydrogen, appears as a static liquid. Considering that the step from the liquefaction of air to that of hydrogen is relatively as great in the thermodynamic sense as that from liquid chlorine to liquid air, the fact that the former result has been achieved in one-fourth the time needed to accomplish the latter proves the greatly accelerated pace of scientific progress in our time.

* See Faraday's Lectures on the Non-Metallic Elements, pp. 292–3.

The efficient cultivation of this field of research depends on combination and assistance of an exceptional kind; but in the first instance money must be available, and the members of the Royal Institution deserve my especial gratitude for their handsome donations to the conduct of this research. Unfortunately its prosecution will demand a further large expenditure. It is my duty to acknowledge that at an early stage of the inquiry the Hon. Company of Goldsmiths helped low temperature investigation by a generous donation to the Research Fund.

During the whole course of the low-temperature work, carried out at the Royal Institution, the invaluable aid of Mr. Robert Lennox has been at my disposal, and it is not too much to say that, but for his engineering skill, manipulative ability and loyal perseverance, the present successful issue might have been indefinitely delayed. My thanks are also due to Mr. J. W. Heath for valuable assistance in the conduct of the experiments.

JAMES DEWAR.

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*SOME RECENT CONTRIBUTIONS TO TERRESTRIAL MAGNETISM.**

DURING the past five years a most remarkable interest in magnetic work has been shown throughout the civilized world. The present time can well be likened to the years when Gauss inaugurated a Magnetic Association, consisting of investigators from all countries, in order to carry out observa-

* A paper read before the Philosophical Society of Washington, March 17, 1900.

tions simultaneously at stated periods, for the purpose of deducing laws governing the complex phenomena of the earth's magnetism, and to recognize harmony in irregularities apparently subject to no law.

Almost every civilized country has either just completed a magnetic survey, or is taking the necessary steps for the inauguration of such work on a grander and more comprehensive scale than ever before. The writer remarked this especially during his recent visit at foreign observatories, undertaken for the purpose of comparing a set of the U. S. Coast and Geodetic Survey instruments with the Observatory Standards. A veritable boom in magnetic work seems to have set in. Thus Eschenhagen, in charge of the magnetic work of the Prussian Meteorological Institute is conducting a magnetic survey of Prussia. Captain Denholm Fraser, of the Royal Engineers of England, is at present actively engaged in making the necessary arrangements for inaugurating a detailed magnetic survey of India and Burma. Captain Lyons, of the Royal Engineers, in charge of the Geological survey of Egypt, who has for some years been making magnetic observations during his journeys in various parts of Egypt, is now planning to make a systematic survey of that country.

The Australasian Association for the Advancement of Science at its Sidney meeting in 1898, on the recommendation of Section A, created a committee for the purpose of promoting the study of Terrestrial Magnetism in the Australasian colonies, and passed a resolution ordering the New Zealand Government, in particular, to establish a permanent magnetic observatory in that colony, and subsequently to initiate a general magnetic survey. The Secretary of the Committee, Mr. C. Coleridge Farr, was very energetic and persistent in arousing the New Zealand people to take an interest in the matter, and the consequence was that the New Zealand Government passed a vote of 500 pounds sterling towards the establishment of a permanent station. Mr. Farr is at present making the preliminary arrangements for the establishment of a magnetic observatory and for the inauguration of a magnetic survey.

As another result of the 1898 meeting of the Australasian Association, the Melbourne Observatory has been granted funds for reducing the magnetic records of the past thirty years. It is extremely fortunate for the advancement of science of Terrestrial Magnetism in this part of the globe that such an energetic and enthusiastic investigator as P. Baracchi is at the head of the Melbourne Observatory.

There have been recently established new magnetic observatories at the following points: Munich, Germany; Genoa, Italy; Mexico City, Mexico. The important advance that this country has made towards setting on foot a detailed magnetic survey of our dominions and for the erection of the necessary observatories has already been described.

With these few prefatory remarks, I will now briefly mention a few of the important recent contributions to our knowledge of Terrestrial Magnetism.

The theoretical investigations of Dr. Adolf Schmidt of, Gotha, Germany.—Dr. Schmidt has just completed an elaborate harmonic analysis of the earth's permanent magnetic field. His investigations are, in a certain sense, an amplification and an extension of Gauss's great work entitled 'The General Theory of the Earth's Magnetism.' Many investigators fail to see that Gauss's investigations elaborated any *theory* of the earth's magnetism and the question, "What is Gauss's theory of the earth's magnetism?" may, therefore, deservedly occupy our attention for a few minutes. Were I asked this question, I would reply as the lamented Herz did in his book on 'Electric Waves,' to the question "What is Maxwell's electro-magnetic theory of light?" Herz's reply was, "Maxwell's theory is that which is contained in his equations defining the electro-magnetic field," and so might I reply if I were hard pressed, that "Gauss's theory is that which is contained in his equations consisting of spherical harmonic terms defining the earth's permanent magnetic field." But what do his equations imply? His equations involve the following theoretical assumptions: That all of the earth's permanent magnetic field is due to causes residing within the earth's crust which are of a character that can be referred to a potential, so that, knowing the value of the potential, all the component parts, namely, that directed north and south along the meridan, that directed east and west along a parallel of latitude, and that directed vertically downward can be readily computed. If now, these theoretical equations, when applied to the actual observations of the earth's magnetic force in various parts of the globe, are satisfied within the errors of observation, then the assumptions underlying the equations have been proved, and that is what Gauss did, and therein, I should say, consists his theory. The equations then represent a definite physical fact.

Now, Dr. Schmidt, in view of the fact that, since the days of Gauss, observations have been greatly multiplied, decided to test the Gaussian hypothesis anew, and so in his analysis he does not begin by assuming the existence of an inner potential function governing the entire magnetic force, but, instead, makes a separate adjustment of each of the three rectangular components and so obtains *three* spherical harmonic expressions instead of *one* as Gauss did. He carries his expressions to terms of the sixth order, Gauss stopping at the fourth. The agreement or disagreement in the coefficients of the harmonic terms in the three separate expressions would test the Gaussian hypothesis, and Schmidt obtains the following conclusions:

The earth's magnetic force consists of three parts:

1. *The greatest part.*—This is to be referred to causes within the earth's crust and possesses a potential.

2. *The smallest part about $\frac{1}{40}$ of the entire force.*—This is due to causes outside the earth's crust and likewise possesses a potential.

3. *A somewhat larger part than the preceding.*—This does not possess a potential, and, in consequence, points to the existence of vertical earth air electrical currents. The currents amount, on the average, for the entire earth's surface, to $\frac{1}{6}$ of an ampere per square millimeter.

Parenthetically, I may remark that Dr. Schmidt is somewhat skeptical about the proof of the existence of the third portion, believing that errors of observation may have produced such a result. I simply wish to emphasize that, in the main, Gauss's theory (and I may now use this expression—having explained what I mean) has been verified.

This indefatigable worker, Dr. Schmidt, has, within a few months, made another notable contribution, namely, on the 'Cause of Magnetic Storms.'

If we compare the photographic traces, obtained at magnetic observatories, showing the variation in magnetic declination or in horizontal intensity during a magnetic storm at two neighboring points, a striking agreement at once appears to the eye. Examine these curves closer and you will find that the agreement consists principally in the number and position of the individual waves or peaks composing the curves, whereas the magnitudes of the corresponding peaks or hollows show distinct differences, so that at times a peak of one curve appears greatly flattened out in the other one, and hence a maximum in one may correspond to a minimum in the other. The farther the stations are from each other, the more frequent and clearer become the differences between the curves, so that at very distant points there are but few details which the curves have in common. Especially characteristic of these fluctuations of the earth's magnetism is the continual change controlling them; remarkable similarity is followed in a few minutes by a pronounced dissimilarity—a violent outbreak in the one curve corresponds to an almost imperceptible bending of the curve in the other. This well known peculiarity in magnetic storms shows without doubt that local influences are the prime cause of the phenomena—occurrences of rapidly changing strength and extent which —now here—now there—make their presence strongly felt, and while the effect may reach practically simultaneously over a very extensive area, the maximum travels rapidly from place to place. Dr. Schmidt made a mathematical analysis of various magnetic storms and in particular of the one which occurred on February 28, 1896, and whose course was followed one hour, from 6 to 7 p. m. Greenwich time, at the suggestion of Professor Eschenhagen, simultaneously by 15 observatories distributed over the earth. His investigations clearly showed that the disturbance vectors at times converged to a point, at other times radiated from a point and, in times of magnetic calms (comparatively speaking), the vectors at the various stations were almost parallel to each other as though pointing to a distant force-center. Furthermore that the points of convergence, in general, moved progressively forward with a velocity of about one kilometer in a second and also that they were at times nearly stationary. In view of the fact that the cause of the diurnal variation of the earth's magnetism must apparently be referred to electric currents in the upper regions of the atmosphere, Dr. Schmidt believes that the immediate cause of the magnetic storms is to be referred to electric whirls or vortices which separate themselves from the general electric field in the atmosphere just as do the cyclones and anti-cyclones known to the meteorologists. Taking also into consideration the vertical disturbing components and applying Ampere's rule to the current systems revealed by the disturbing forces, it follows that, for the greater part, the causes of our observed magnetic storms come from outside of the earth's crust.

Professor Eschenhagen's recent work follows naturally upon this brief statement of the work of Dr. Schmidt, for it is largely due to his energy and the instrumental methods he has devised that Dr. Schmidt's investigations have been made possible.

We shall have thrown, presently, upon the screen a lantern slide showing the delicate transportable variation instruments devised by Eschenhagen. The results reached by him with these instruments revealed the desirability of again inaugurating a system of simultaneous observations of the earth's magnetic variations at various points, and so was begun the scheme of observation which furnished Dr. Schmidt with the necessary material. Eschenhagen has likewise made some very interesting investigations as to the effect of Berlin electric tramways at various distances, with the aid of his simple set of variation instruments.

You will see later on the screen curves obtained by these instruments showing the effect of the tramways at various distances. If these small variation instruments prove upon trial, covering a sufficiently long period, to be satisfactory in every respect, their small initial cost and also that of their maintenance will, without doubt, do much towards increasing the number of stations recording the variations of the earth's magnetism, and so we may hope some day to get the material that is needed for a satisfactory study of these phenomena.

Dr. W. van Bemmelen, who has succeeded Professor van der Stok as Director of the Batavian Magnetic Observatory, has recently issued a new set of isogonic charts for the epochs 1500, 1550, 1600, 1650 and 1700. Magneticians owe a great debt of gratitude to this enthusiastic and painstaking investigator for the exhaustive search he has made for old magnetic data in the various European libraries. Only one who is engaged in similar work can appreciate the amount of love and perseverance necessary for such work. It is also exceedingly gratifying and commendable that the author gives in his publication the data upon which the charts are based.*

L. A. Bauer.

U. S. Coast and Geodetic Survey.

EXOTIC MOLLUSCA IN CALIFORNIA.

The number of foreign molluscan species in California has notably increased in the past few years, and includes both terrestrial and marine forms, detected by various collectors in and around San Francisco bay.

With the single exception mentioned below, the introduction of these exotic forms has been purely accidental, simple incidents in the usual course of business traffic or commercial interchange.

First, among the land shells we find the well known snail *Helix aspersa*, a common European species, largely used for food on the continent and familiar to persons who have patronized the restaurants of Paris. This species was intentionally introduced or 'planted,' in California over forty years ago by Mr. A. Delmas, of San José, Santa Clara county, who brought the stock from France and turned it out among the vineyards on the west bank of the Guadalupe, a small river that flows northerly through Santa Clara Valley and empties into the southerly end of San Francisco bay near Alviso. The soil where the snails were placed is a rich sandy loam and the place well shaded. When the summer heats reach the maximum, the *Helices* descend into the ground several feet, hiding in the cracks that form, as the ground dries, and the gopher-holes also furnish cool retreats and protection. The region above named is one of exceeding fertility. It was settled by a few French families. The introduction of *H. aspersa* by Mr. Delmas was made for edible purposes, or in common parlance 'with an eye to the pot.' Mrs. Bush, of the Normal School in San José, informs me that the snails have thriven, and have extended their territory from the starting point on the west bank of the stream to the easterly side, and have multiplied to such an extent, that in some instances they are troublesome in the gardens. Mr. Delmas, the elder, also planted *H. aspersa*, in San Francisco and Los Angeles. I have never met with it in my collecting rambles in San Francisco or the outskirts of that city, nor heard of its having been detected by any collector. This particular plant was probably a failure, for a more unfavorable region than that of San Francisco forty years ago, with its cold sea winds, fog, sand-dunes and shifting sands and sparse ligneous scrubby vegetation it would be hard to find. At the present day the chances for success are altogether better, for the greater area of the city is covered by residences, with plats of grass, garden patches and flower-beds which are frequently watered and the general conditions are more promising. It would doubtless

*In connection with above paper there were exhibited 30 lantern slides, consisting of portraits of prominent magneticians, views of magnetic observatory buildings and instruments, and of photographic traces derived from magnetographs.

find a congenial environment in Golden Gate Park; its occurrence there is only a matter of time. I have learned recently that some party in the westerly section of the city propagates or did propagate *H. aspersa*. Mr. Fred L. Button, of Oakland, has informed me that it occurs* in many of the gardens and private grounds in that place, and that one of his neighbors employed a man half a day 'cleaning them out of his garden.' Professor Keep, of the Mills College, last summer collected 'a fine living specimen' at Pacific Grove, Monterey, which is more than fifty miles south of the original Delmas plant on the Guadalupe.

It is now common in East Side Park and is also reported as occurring in Elysian Park in Los Angeles. These are, no doubt, the descendants of the stock planted by Delmas so many years ago.†

Mr. W. G. Binney, in his 'Terrestrial Air-breathing Mollusks of North America etc.' (Vol. V., July, 1878), reports *H. aspersa*, as found "In gardens in Charleston, S. C., and vicinity, where it has existed for fifty years; * * * it has also been found at New Orleans and Baton Rouge; Portland, Maine; Nova Scotia; Santa Barbara, Cal.; Hayti; Santiago, Chili; etc.;" and Mr. Binney, if I am not mistaken, has raised them in his grounds at Burlington, N. J. As he says, "it evidently is a species peculiarly adapted to colonization."

I have always doubted its occurrence at Santa Barbara; it has never been confirmed by any collector to my knowledge. It was, in the first instance, credited to this place on the testimony of a communication to the Zoological Society of London, by Professor Edward Forbes, in which were described the shells collected in the course of surveying voyages of Captain Kellett and Lieutenant Wood of the Royal Navy, in the ships *Herald* and *Pandora*. The locality marks and labels were, unfortunately, badly mixed, and confusion was the inevitable result—Lower California species were credited to the far north, and so on.

A recent careful inquiry made for me by a friend utterly failed to obtain any data, showing its existence at Santa Barbara * or thereabout at any time.

From the foregoing it will be seen that this species is fully established on both coasts of the United States and it is likely to extend its territorial domain in harmony with the prevailing spirit of the times.

Living *Helix pomatia*, a larger species, also European, has been imported by a leading grocery firm in San Francisco to supply its patrons. This is the snail *par excellence* of Continental epicures and was propagated on an extensive scale in the palmy days of ancient Rome as a dainty for the patrician palate on festal occasions; it is not unlikely that sooner or later this species also will be found in some congenial spot outside of the grocery store and in course of time become an inhabitant of California.

More than fifteen years ago a species of slug, *Amalia Hewstoni*, made its appearance in the grass plots of San Francisco; it was described by Dr. J. G. Cooper. It soon became a nuisance; even a regularly ordained clergyman spoke of it as 'a slimy brute'; however this may be, it has now 'expanded' its territory so as to include Seattle in the north and San Diego in the south. Dr. Pilsbry says it may be identical with the

My esteemed friend, the late Dr. Newcomb, who lived in Oakland many years, may have planted some in his garden as an experiment. He had at one time on his grounds several living California forms of different species.

† I have been told that the employees in the park are of the opinion that it was incidentally introduced with foreign plants. They are not aware of the Delmas fact. Its presence in the park may, perhaps, be due to both.

* Vide my paper 'On *Helix aspersa* in California,' in Annals of New York Acad. Sciences, May, 1881, pp. 129–139.

European *A. gagates*; it is not a native Californian. In addition to examples of *Helix aspersa* I have recently received specimens of *Zonites* (*Vitrea*) *cellaria* Müll. and *Zonites* (*Vitrea*) *draparnaldi* Beck, and the little bulimoid, *B. ventrosus* Fer, all from the lawns and flower-beds of Oakland, collected by Henry Hemphill.

Of the above, *Z. cellaria* has an almost world-wide distribution through the instrumentality of commerce. On the Atlantic side from Quebec to Charleston, S. C., along the coast, inland (in greenhouses) at Alleghany City, Pa., and Detroit, Mich. *Z. draparnaldi* is found in the greenhouses of Seattle according to Dr. Pilsbry and has before been reported as occurring in Oakland. The little bulimoid form detected by Mr. Hemphill has not, to my knowledge, been previously found anywhere in North America. It is a continental species. I do not find in the books, any intimation of its occurrence in the British Isles though its absence from territory so comparatively near is remarkable. It has been reported from Bermuda. The occurrence of these European forms of *Zonites* and *Bulimus* in the gardens of Oakland are quite likely due to plant importations. A single example of the little *Helicodiscus lineatus* Say, was noticed by me several years ago, as having been collected in Oakland by Mr. Hemphill. Binney* says of this peculiar form, that it "inhabits all of the Eastern, Central and Pacific Provinces, having been found from Gaspé to Texas; on the Rio Chama, New Mexico; in Idaho; in Oakland, Cal." This is misleading, as it has not been detected anywhere within the Pacific province as defined by him outside of Oakland, and only here in the single instance above mentioned. Mr. Hemphill has also collected *Cochlicopa lubrica* Müll. (= *Ferrussacia subcylindrica* L.) on Grizzly Peak back of the university grounds at Berkeley. This form has heretofore been reported from Oregon and Alaska, and presumably belongs to the circumboreal fauna.

* Manual of American Land Shells, Bull. U. S. N. Mus. No. 28, 1885, p. 75.

MARINE SPECIES.

Having completed our review of the terrestrial species, we may now consider the marine forms, which are confined almost exclusively to San Francisco bay.

The presence of the Virginia oyster in this region is wholly due to business enterprise; its introduction dates from about the time of the completion of the overland railways. Upon the completion and operation of the transcontinental lines certain of the San Francisco oyster dealers commenced the importation by the carload of small or seed oysters, one and two years old, from the Atlantic side, for planting in San Francisco bay, where after a couple of years they attain a marketable size. These importations of *Ostrea Virginica* have been continued ever since, as this species, owing to some unfavorable peculiarities in the new environment, does not increase sufficiently to meet the demands of trade.

The importations of the seed oysters for the nine years, ending with 1895,* amounted to 15,271,000 pounds, costing $350,000.

As an incident of these importations we find several familiar species have been unintentionally introduced, some of which have already established themselves, and appear to be permanently naturalized, as well as others that are gaining a foothold.

The most important of these accidental introductions is the common sand-clam, *Mya arenaria* of the Atlantic Seaboard, variously known as the 'soft-shelled,' 'squirt,' 'long-necked,' clam, and 'mananose.'

There probably has never been in the history of commerce an instance of an accidentally introduced animal species that has proved so economically valuable as this.

* Report of U. S. Fish Com. for 1896.

It was first detected on the eastern shore of the bay, in November, 1874, by Mr. Hemphill, and was soon after described from his specimens, which were about two-thirds the average adult size, by the late Dr. Wesley Newcomb, as *Mya Hemphillii*. It has multiplied wonderfully and is found everywhere in the Bay region, and has apparently crowded out certain indigenous forms like *Macoma nasuta*, before the advent of *Mya*, one of the commoner clams; it is now comparatively scarce. While the shells of *Macoma* are abundant in the kitchen-middens and aboriginal shell-heaps and mounds that are so numerous on the adjacent shores, not a sign of *Mya* has been detected. There is not the slightest doubt of the introduction of the latter form in the way indicated.

Some fifteen or twenty years ago, it happened that I was an invited guest at a clam-bake on the Sausalito shore, and made the acquaintance of the presiding genius of the culinary department, himself an interesting specimen, a cross between fisherman, clam-digger, cook and sea-dog, a sort of 'alongshore jack-at-all-trades.' We had a prolonged confab about clams and clam-bakes. The discussion closed with the remark by him, "what a heap o' shekels I could have made in early days, if these squirt-clams had been in the bay."

Notwithstanding the great increase in the population of San Francisco, Oakland and other cities and towns in this general region and the consequent increased demand, the clam-beds exhibit no hints of depletion. They furnish an abundant supply of wholesome and nutritious food, and that, too, at an exceedingly low price, for the solid meats are retailed in the markets at fifty cents per gallon.

Plantings of *Mya* have been made at Santa Cruz and perhaps elsewhere in the south, and in Shoalwater bay in the north. The latter by Captain Simpson, of San Francisco, many years ago, who informed me that his experiment was a success and had resulted in an ample harvest. It has also been planted elsewhere on the coast of Washington and in Coos Bay near Marshfield, Oregon.

The fusiform species, *Urosalpinx cinereus* Say, the oyster-drill of the Atlantic coast, was discovered on the oyster beds near Belmont on the westerly shore of the San Francisco bay as long ago as 1889, by Mr. C. H. Townsend, of the United States Fish Commission. It was detected last year by Mr. E. E. Smith, of Stanford University, near Redwood City, on the same side of the bay, to the south of Belmont.

Mr. Hemphill collected it in 1898 on the old oyster beds on the Alameda flats of the Eastern Shore, a dozen or more miles from the other localities. At the last named place Mr. Hemphill has recently detected the 'slipper shell,' *Crepidula convexa* Say var. *glauca* Say. The familiar form, *Modiola plicatula* Lam., was found, living, at a point three miles north of Stanford University, in 1894, by Mr. N. F. Drake. This species which ranges on the Atlantic side, from Nova Scotia to Georgia, was particularly abundant fifty years ago in that part of the city of Boston known as the Back-bay district, now traversed by beautiful streets and avenues and exhibiting many fine examples of architecture. By the filling in of this extensive area several hundred acres of wet and dry marsh-land and mud-flats, countless thousands of this *Modiola* were buried alive. It remains to be seen, whether at any point on the Pacific Coast, this form will become approximately as abundant.

It will be noticed from the foregoing that twelve exotic species of Mollusks occur or have been detected in California.

1. *Helix aspersa* Müll.
2. *Amalia Hewstoni* Cp.
   (= *A. gagates*).
3. *Zonites* (*Vitrea*) *cellaria* Müll.
4. *Zonites* (*Vitrea*) *Draparnaldi* Beck.

5. *Bulimus* (——) *ventrosus* Fer.
6. *Helicodiscus lineatus* Say.
7. *Cochlicopa lubrica* Müll.
(= *Ferrussaccia subcylindrica* Linn.)

of Europe, and

8. *Ostrea Virginica* Gmelin.
9. *Mya arenaria* Linn.
10. *Modiola plicatula* Lam.
11. *Urosalpinx cinereus* Say.
12. *Crepidula convexa* var. *glauca* Say.

of the Atlantic seaboard.

With the exception of numbers 2 and 7 examples of the foregoing have been placed in the National Museum.

Robert E. C. Stearns.

Los Angeles, Cal.

SCIENTIFIC BOOKS.

MANUAL AND MECHANICAL PRODUCTIVITY.*

The report of the United States Commissioner of Labor, Mr. Carroll D. Wright, recently issued, on 'Hand and Machine Labor,'* like all our reports from that source, is rich in facts and data. This report has, naturally, in consequence of its intrinsic importance, as well its admirable form and wealth of information, attracted much attention. Mr. Wright has himself given a resumé of the work in the March issue of *Gunton's Magazine ;* London *Engineering* and the *Scientific American* devote space to a summary and we now find in the February number of the *Bulletin de la Société d'Encouragement, pour l'Industrie nationale*, an elaborate article by the distinguished French writer, M. E. Levasseur, in which the abstract of Mr. Wright's report constitutes the *pièce de résistance*. The facts illustrated in this remarkable document are, in substance, the following :

The comparison made is, in general, with the methods of the earlier times, antedating the present system of machine-production in which the hands and even the brains of the workmen are reinforced and made enormously more productive by the employment of machinery of great power, activity, accuracy and endurance. It is the comparison of the work and productivity of the days of unaided manual labor of the last century with the production of our own time of labor-aiding machinery and of industrial organization. The real progress described, surprising as it may seem, has actually taken place mainly in the last half century, and in large proportion since about 1870, the date of initiative assumed in Mr. Wells' famous 'Recent Economic Changes.' Within this period, the changes have been studied in eighty-eight principal industries and about seven hundred subsidiary lines. All the data are tabulated in convenient form and the presentation thus made is most admirably adapted for the purposes of the economist, the engineer and the manufacturer interested in the principles of economics controlling his art.

The general deductions are that, while the number of operations in the production of each article has usually considerably increased, and while the machine with its attendant turns out enormously larger product than the unaided workman, the time required for the production of a given amount of product has quite as extraordinarily decreased ; the costs of prodnct have proportionally decreased ; the market has been enormously expanded and, unexpected but true, the number of workmen has very greatly increased in each industry thus aided and their wages have followed the upward trend of production. Thus, lower prices of product, and larger production with rising wages for more workmen employed, have been consequent upon the work of the inventor and the genius of the 'entrepreneur,' as the economists, curiously, often denominate the manufacturer and the organizer of industries. Invention has immensely augmented, rather than displaced, labor in every manufacturing industry; not even excepting agriculture, where the inventor has supplied the mower and the reaper, the seeder and threshing machine to increase the effectiveness of the manual worker ten times over.

M. Levasseur, in his extended study of such comparisons of the work of the unaided hand with the work of that machine-assisted, traces the history of the introduction of inventions and machinery, with the gradual rise and more gradual fall of the ignorant prejudice of

* Thirteenth Annual Report; Washington Gov't Print. 1899. 2 Vols. Pp. 1597.

the people most advantaged by improvements made by the inventor, and shows, ultimately, that what he calls the 'Economic Paradox' finds place in all machine-reinforced industries. This principle is: the costs being given in detail, it will be found that, with stated costs, there is a certain production which will give the largest dividends. There is a 'golden mean,' as the writer has been accustomed to call it, when developing a similar principle in the production of power from the heat-engines, departing from which, in any direction, efficiency will be sacrificed and the returns on the investment reduced. This is probably true of any one element of production, varying alone. This economic law is well illustrated in the preceding case by the reversal of the 'law of supply and demand,' as usually stated without qualification, by the progress of invention and organization; giving increased employment by giving one man the power to do the work of many, by raising wages while increasing production and giving enlarged profits while reducing prices; extending markets faster than increased production by labor-assisting machinery can supply them and affording employment to increasing numbers of workmen; elevating them from the lower to the higher strata, while giving work of any stated amount, in product, to a fraction of the number of men formerly required.* The cost of plows, for example, as given by Mr. Wright in his report, has fallen from $54 to $8 and less, each; while the time demanded for production per unit, is reduced from 1180 hours to less than 40. Meantime wages have doubled and quadrupled, and, even at the higher price, labor is eight times as effective as formerly. The user of the plow reduces cost of labor, per acre of ground cultivated, from $3.55 to $0.66 reinforcing his own strength by the machine in nearly every operation, from seedtime to harvest.

The agriculturist, with the aid of machinery, supplies butter of a perfectly uniform and better quality, as an average, by the use of machinery, reducing costs, per 500 pounds, from $10.66 to $1.78. The number of butter-makers has been enormously increased in this period, while the product is made in one-tenth the time and at one-sixth the cost of that of our grandfathers.

Four hundred carriage-axles once cost, for labor, $56.97, and now cost $8.20. Many more men are employed in the industry and the work is done ten times as fast and at one-seventh the cost for work. Similarly, 1000 watch-movements once cost $80,822, and now cost less than $1800; while the number of operations has been quadrupled and the time reduced to one-thirtieth. Five hundred yards of cloth, once costing $135, hand-made, now cost $6.81; 100 pairs of boots then cost $408, and now $35, hand-made and machine-made, respectively; time required is reduced, on the cloth, to one-half of one per cent. of its former value and, in the case of the boots, to ten per-cent. On 20,000 nails, $20 were once expended and now but 29 cents; while the time was then 150 times as great and the cost about 100 times as large as to-day. These are examples of the drift of the inquiry and its outcome.

It is thus evident that the use of labor-assisting machinery—less appropriately called 'labor-saving'—has permitted an enormous increase in the number of people employed in manufacturing, and, while increasing the number of operations in the making of each article, has reduced the time required to a fraction, often a minute fraction, of that formerly demanded, and has decreased the costs of product enormously. Meanwhile, it is known that the wages paid for labor in these directions have greatly increased and, with reduction of costs, their purchasing power has been, at the same time, immensely enlarged. Similar observations in France, reported by M. Levasseur, give precisely the same general results.

"*Abondance, puissance, économie: voila donc trois effets de l'emploi des machines qui sonts évidents,*" concludes M. Levasseur.

Mr. Wright's own summary of his work in this field adds the following deductions: "Machinery has established, or brought into activity, new principles in statute law; it has wrought many changes in common-law doctrine. It has increased opportunities to enjoy art and

* This principle was illustrated admirably in the case of copper-production, where rising wages and falling prices have continued for now many years. See SCIENCE, Dec. 4, 1896, page 817.—R. H. T.

literature, has lessened the frequency and the possibilities of famines, has increased longevity by making life safer and more comfortable. It has extended marvelously the power of production, and, consequently, of consumption. It has made the world cosmopolitan, upsetting old ideas and old customs. It has lifted struggling humanity to a higher plane and has stimulated a higher intelligence."

In agriculture our 45,000 workers are aided by the equivalent, in brain-power, crystallized in machinery, of over 300,000 men. Our 225,000 workers in cotton manufacture are aided by the equivalent of about three millions, by the multiplication of their productive power by use of their labor-assisting machinery. In flouring mills, 65,000 workers in the United States are made equal to nearly five millions. In paper-making, 30,000 men become equal to a million and a half. These workers of the United States, four and a half millions of men, with machinery at their finger-ends, turn out a product that it would require nearly forty millions of men to produce by hand. Locomotives, alone give us the equivalent of the working power, if unaided, of three hundred and fifty millions of men. Our own people derive about twice as great advantage from labor-assisting machinery as do European nations; the population of the United States being equal in productive power to 150,000,000 Europeans. Says Mr. Wright:

"The reflection comes that a labor-saving machine is best defined as a contrivance by which the dead still work. For the motive power of steam is the stored heat of the sun converted into present power. That heat gives force to the present era; while the intelligence of the inventors of motive power, or of the machines which control it, and their workmen are still working in unconscious iron and converting the heat into motion and doing the work of the world." Thus the machine "has practically enabled one generation of men to do the work of four or five generations."

The deduction of the editor of the *Scientific American* is that machinery, by raising wages, increasing their purchasing power, also thus lowering costs of all the necessaries of life, has become recognized "not, as the agitator will even yet suggest, the enemy of labor, but in every respect its best friend."

R. H. THURSTON.

Outlines of the Comparative Physiology and Morphology of Animals. By JOSEPH LE CONTE. New York, D. Appleton & Co. 1900. Pp. xviii + 492.

The impression given by the general appearance of this book is very favorable; print, illustrations, paper and binding are all good. A rapid turning over of the pages at first confirms this impression for the general plan of the work is most admirable. Function is the basis of the work and structure is described only so far as is necessary for the proper understanding of function. In short it continually reminds one of that admirable volume of a generation ago, the Principles of Zoology which was prepared by Agassiz and Gould and which served as the inspiration of many a youth.

In his treatment Professor Le Conte begins with some general accounts of life, cells and histology and then follows a general account of the organs and functions of animals, classifying them as the animal and the vegetative functions. In the treatment throughout man is made the type and the subject is treated in the descending scale.

A work built on these lines might be made almost ideal as a text-book for our schools, but not with our present knowledge. There are too many unknown quantities upon the physiological side. Professor Le Conte's book has also another shortcoming. It contains too many inaccurate statements. On the whole it is better upon the physiological side than where it attempts to deal with morphology, yet here it is far from free from error and ambiguity. Thus the account (p. 5) of the characteristics of plants is true only of the chlorophyl bearing forms; thus, again, the only suggested function of motor nerves is to cause muscular contraction; thus (p. 65) the electrical organs of a fish are stated to be organs for the conversion of nerve force into electricity just as a muscle is a structure for converting nerve force into mechanical power. On p. 58, along with an erroneous conception of the paths of sensory conduction, the ganglion cells of the dorsal roots are placed in the posterior cornua of the cord. On p. 94 we find the statement that the fibers of olfactory and optic nerves are specialized for recognition of odors and light. Is not this rather a matter of nerve termination? In treating of the ear we find the statement that "in the vestibular sac and attached to the hair-like nerve terminals there are several little sand-like grains of carbonate of lime (otoliths)" and here and elsewhere the author seems to regard the sensory hairs as the terminations of nerves. On p. 218 it is stated that animals lower than hexapods are not known to make sounds intended to be heard. What shall be said of the stridulation of spiders and crabs? On p. 399 the aëration of the crustacean gill is in part attributed to ciliary action regardless of the fact that cilia are unknown in arthropods. The scaphognathite of the decapods is ignored. P. 342, the function of the echinid pedicellariæ is stated to be to convey food to the mouth. In the account of the evolution of the ruminant stomach (p. 317) the author is again at fault, for this complicated structure is not derived by simple division of a stomach like that of man, but by the incorporation of a part of the œsophagus into the organ. Again (p. 435), renal organs are stated to occur only in vertebrates, molluscs and arthropods. Where is the nephridial system of the worms, and have not the contractile vacuoles of the ciliates been shown to void sodium urate? P. 404, the respiration of the star-fish is said to be produced by drawing water into the perivisceral cavity through a multitude of pores but the branchiæ are ignored; while *Echinus* is stated to have tufted external gills around the mouth. The worst feature, physiologically, of the book is the recognition of a vital force.

On the morphological side the errors are far more numerous and we can only call attention to a few. Thus (p. 7) 'all animals must have a stomach"; how about tapeworms? P. 85, 'It is difficult, indeed impossible, to conceive how the vertebrate nervous system could have been evolved out of that of the articulates." Cannot exact homologies be shown between the two? Cannot we compare the distribution of white and gray matter and the origin of the ganglionated roots in both? On p. 91 a pedal ganglion is denied to the oyster. On p. 165 the optic ganglion is stated to act as a retina in the arthropod eye. On p. 172 the vertebrate lens is stated to be comparable to the invertebrate eye. Amphibians are stated (p. 184) to lack a middle ear; this is not true of Anura. On p. 186 the mosquito is credited with two pairs of antennæ. On p. 247 it is stated that we cannot trace homologies except within the primary branches —vertebrates, articulates, molluscs and radiates. What has become of Huxley's comparisons of ectoderm and entoderm of coelenterates and mammals, to say nothing about such homologies as can be drawn between nervous system, nephridia, cœlom and the like? Here and there we meet with statements regarding a radiate type of structure and a recognition of close affinities between coelenterates and echinoderms.

Again, the vertebral theory of the skull is maintained in several places, although it is stated that there is 'some doubt' if it be strictly true. Then there is no recognition of the fact that ribs are not homologous throughout the vertebrates. At various places it is stated that serial homology (metamerism) is mostly limited to the skeleton and the nervous system and is denied to the organs of vegetative life. There is no recognition of the fact that metamerism is mesodermal in origin; and none of metamerism in nephridia, blood vessels, gonads, etc. In the final section we meet this astounding statement (p. 481): "On the east coast of the United States we have two abrupt changes of coast fauna, one at Cape Cod and the other at Cape Hatteras. Scarcely a single species passes from north to south of these points, or *vice versa*."

The foregoing errors have been selected to emphasize the charge of inaccuracy, but a more serious fault is the lack of a broader grasp of the results of recent morphological and physiological research. This is not easy to illustrate, but is very apparent on reading the pages.

J. S. Kingsley.
Tufts College.

BOOKS RECEIVED.

The Norwegian North Polar Expedition, 1893–1896 Scientific Results, Edited by Fridtjof Nansen. New York, London and Bombay. Longmans, Green & Co., 1900. Vol. I. Pp. viii+141, 44 plates. $15.00.

The Unknown. CAMILLE FLAMMARION. New York and London, Harper & Brothers, 1900. Pp. xii + 488. $2.00.

Brief Guide to the Commoner Butterflies of the Northern United States and Canada. SAMUEL HUBBARD SCUDDER. New York, Henry Holt & Co., 1899. Pp. xi+210.

Commercial Organic Analysis. ALFRED H. ALLEN. P. Blakiston's Son & Co., 1900. Vol. II., Part II. Pp. viii+330.

Inorganic Evolution as studied by Spectrum Analysis. New York and London, The Macmillan Co., 1900. Pp. x+191. $1.75.

SCIENTIFIC JOURNALS AND ARTICLES.

THE March number of the *Bulletin of the American Mathematical Society* contains the following articles: 'Mathematical instruction in France,' by Professor James Pierpont; a review, by Professor E. W. Brown, of Poincaré's Cinématique et Mécanismes, Potential et Mécanique des Fluides; 'Shorter Notices'; 'Notes'; and 'New Publications. The April number of the *Bulletin* contains a report of the February meeting of the Society, by the Secretary; 'Some theorems concerning linear differential equations of the second order,' by Professor Maxime Bôcher; 'Note on the enumeration of the roots of the hypergeometric series between zero and one,' by Dr. M. B. Porter; 'The summer meeting of the Deutsche Mathematiker-Vereinigung, at Munich, September, 1899,' by Professor James Pierpont; reviews of Hilbert's Grundlagen der Geometrie, by Dr. J. Sommer, and of König's Leçons de Cinématique, by Professor E. O. Lovett; 'Notes'; and 'New Publications.'

THE *Journal of the Boston Society of Medical Sciences* for March 20th, is largely devoted to abstracts of the papers read at the first meeting of the Society of American Bacteriologists, held at New Haven, Dec. 27–30, 1899. Several of these dealt with the question of purification of sewage and contamination of water supply. Charles S. Minot has a paper 'On the Solid Stage of the Large Intestine in the Chick, with a Note on the Ganglion Coli.' W. T. Councilman discusses 'The Lobule of the Lung and its Relation to the Lymphatics,' and Thomas Dwight notes a case of 'Absence of the Inferior Vena Cava below the Diaphragm.'

SOCIETIES AND ACADEMIES.

THE NATIONAL ACADEMY OF SCIENCES.

THE annual stated session of the National Academy of Sciences was held in Washington, April 17–19, 1900, with Dr. Wolcott Gibbs in the chair, and the following members in attendance: Messrs. Abbe, Agassiz, Allen, Barus, Beecher, Bell, Billings, Boss, Brewer, Brooks, Brush, Chandler (S. C.), Chittenden, Comstock (G. B.), Dall, Dana, Dutton, Elkin, Emmons, Farlow, Gibbs (W.), Gilbert, Gill, Hague, Hall, Hill (G. W.), Langley, Mitchell (S. W.), Morse, Powell, Putnam, Remsen, Rowland, Schott, Smith (E. F.), Walcott, Welch, White and Wilson.

The resignation of Dr. Wolcott Gibbs as President of the Academy was reluctantly accepted to take effect at the close of the session. Hi-successor will be elected at the next April sess sion.

Six additional members of the Council were chosen for the ensuing year, as follows: Messrs. J. S. Billings, H. P. Bowditch, G. J. Brush, Wolcott Gibbs, Arnold Hague, Simon Newcomb.

The following gentlemen were elected members of the Academy: James E. Keeler, Director of the Lick Observatory, Mt. Hamilton, Cal.; Henry F. Osborn, of Columbia University, New York City; Samuel L. Penfield, of Yale University, New Haven, Conn.; Franz Boas, of Columbia University, New York City.

The Academy adopted a report from the Trustees of the Barnard Medal recommending that the medal be awarded to Wilhelm Conrad Röntgen for his discovery of the X-rays. This medal is awarded at the close of every quinquennial period to such person as shall, within the five years next preceding, have made such discovery in physical or astronomical science, or made such novel application of science to purposes beneficial to the human race, as, in the judgment of the National Academy of Sciences of the United States, shall be esteemed most worthy of such honor.

Mr. Agassiz offered to give to the Academy the sum of $5000 to be a part of a contribution to a building fund to erect a building for the use of the Washington Academy of Sciences and the local or affiliated societies, on condition that the land needed for such a building be given by the Government or obtained from other sources, and furthermore, that the sum of $100,000 at least be raised for that purpose, and that the National Academy of Sciences have such privileges granted as they may need.

Mr. Agassiz also offered to give $1000 towards a general fund for the National Academy of Sciences, provided that $20,000 be raised for that purpose. Mr. Theo. Gill offered to donate $500 to the general fund. These offers were accepted by the Academy, and committees will in due time be appointed to obtain subscriptions to these funds.

The following papers were read in the scientific session:

I. 'The Anatomy of *Nautilus pompilius*': L. E. Griffin. (Introduced by W. K. Brooks.)

II. 'West Indian Madreporarian Polyps': J. E. Duerden. (Introduced by W. K. Brooks.)

III. 'On the Use of Electric Motors, of the Shunt Type, for Solving Linear Differential Equations of any Order with Variable Coefficients': Reginald A. Fessenden. (Introduced by Cleveland Abbe.)

IV. 'On the Prediction of the Physical Properties of the Pure Metals': Reginald A. Fessenden. (Introduced by Cleveland Abbe.)

V. 'A Partial Explanation of some of the Principal Ocean Tides': Rollin A. Harris. (By permission of H. S. Pritchett. Introduced by Cleveland Abbe.)

VI. 'Secondary Enrichment of Sulphides in Ore Deposits': S. F. Emmons.

VII. 'The Cruise of the U. S. Fish Commission Steamer *Albatross* in South Seas, August, 1899, to March, 1900': A. Agassiz.

VIII. 'On the Zoogeographical Relationships of Africa': Theodore Gill.

IX. 'Report of the Watson Trustees on the Award of the Watson Medal to David Gill': Simon Newcomb.

X. 'A Human Bone from the Glacial Deposit at Trenton, N. J.': F. W. Putnam.

NEW YORK ACADEMY OF SCIENCES. SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

A meeting of the Section was held on Monday evening, April 2nd. Professor William Hallock, of Columbia University, discussed the overtones of a tuning fork. The first regular overtone of a tuning fork is about two and a half octaves above the fundamental, but Lord Rayleigh pointed out that when the amplitude of the vibration became so great that the restoring force was no longer proportional to the displacement, the octave appeared, as indicated by theory. Lord Rayleigh recognized the presence of the octave with his ear, and by the use of a resonator. Professor Hallock obtained direct evidence of this effect by means of a photograph of a manometric flame, the capsule of which was resting against the prong of the fork.

In a paper on 'Specific Gravity Weighings,' Professor Hallock spoke of a number of points in which the ordinary operations can be improved. It is very convenient to use the principle of the Jolly balance, in which there is a pan always immersed, to hold the body when weighing it in water. The effect of capillarity on the supporting wire, which at best lessens the sensibility of the balance, can be avoided by sending a series of little waves across the surface of the water while weighing. To get rid of bubbles in little corners of irregular bodies, these bodies may be held under the tap at the sink and moistened with water before immersion, or still better, they may be moistened with alcohol and then with water before immersion.

Professor M. I. Pupin of Columbia University, described a new faradmeter which he had devised, an instrument for measuring the capacity of a condenser. This instrument is essentially a Wheatstone's bridge using alternating currents, in which one leg of the bridge consists of two resistances in series, and the other leg consists of two capacities in series, one of the two being that of a standard condenser, the other being the unknown capacity to be measured. In the bridge connecting the two points, one between the two resistances, the other between the two capacities, is a telephone. If the two separate circuits each containing one of the two capacities, are arranged so that the capacity reactance is by far the greatest part of the impedance in that circuit, then silence in the telephone will be obtained when the two resistances are to each other inversely as the two corresponding capacities. The apparatus has been employed in the Columbia University laboratory and gave complete satisfaction. It is capable of a tolerably high degree of accuracy, but its principal merit is its convenience.

Professor J. K. Rees presented a paper by Miss C. E. Furness on a 'Catalogue of stars within one degree of the North Pole, and the optical distortion of the Helsingfors astrophotographic telescope.' The paper gave the results of measurements on 65 stars. By taking stars near the pole, the same group of stars can be taken at different angles with reference to the object glass of the telescope. At Helsingfors the pole is sufficiently far from the horizon to avoid trouble with refraction. From the measurements the distortion of the Helsingfors lens was found to be not appreciable.

Wm. S. Day,
Secretary.

TORREY BOTANICAL CLUB.

At the meeting of the Club on February 28th the first subject on the scientific program was a 'Note on Apeiba,' by Dr. D. T. MacDougal, who showed specimens of leafy branches of this Tiliaceous tree, exhibiting flowers apparently seated on the leaves, an accidental but frequently quite stable position, due to abundant blossoms dropping from above, piercing the lower leaves and lodging there. Dr. MacDougal witnessed this peculiarity in trees cultivated in Jamaica, originally from British Guiana.

The principal paper of the evening was a discussion by Dr. N. L. Britton 'On the Flowering Plants collected by Mr. R. S. Williams in the Yukon Territory, 1898–1899.' Dr. Britton exhibited the plants collected, and by means of a sketch map of the region he compared the diverse floras of the Alaskan region. Mr. Williams' collection contains several new species and several others which are new to North America. The Ferns, Lycopodia, etc., of Mr. Williams' collection were reviewed by Dr. Underwood and Professor Lloyd. They include such widespread forms as *Cystopteris fragilis*, *Polypodium vulgare*, *Selaginella rupestris*, and species of *Equisetum* and of *Lycopodium*, including *L. annotinum*, and *L. Selago*. The Conifers include *Tsuga Mertensiana*. Dr. Britton is still engaged on a study of the similarly abundant Sedges, with several peculiar forms. *Carex vesicaria* is there cut for hay. *Eriophorum vaginatum* and *E. polystachyon* grow there also. The eight orchids were worked over by Dr. Rydberg.

The Birches are interesting, one of them new to North America. Another new birch has just been described from the Alaskan coast, but this is wholly different. Two *Polygonum* species occur, *P. viviparum*, and another peculiar to Alaska. *Rosa acicularis* occurs there, and one violet, *V. Macloskiei*. The Buffaloberry, *Shepherdia*, is there a shrub; *Cornus Canadensis*, *C. stolonifera*, *Empetrum nigrum*, etc., are present. Only three Umbelliferæ were collected. An important part of the flora is formed by the Heath family, about 20 species, *Dodecatheon* is there, *Primula Sibirica*, a *Gilia*, two species of *Polemonium*, a new *Mertensia*; only one Labiate; *Gentiana propinqua*; *Menyanthes trifoliata*; *Plantago aristata*; *Galium boreale*; *Linnæa borealis*; *Viburnum pauciflorum*; a new Valerian, etc. On the whole the flora is not so fully Arctic as we might have expected from the latitude.

Mr. R. S. Williams, the collector of these specimens, said there were few shrubs there except willows; for miles all is covered by spruce 15 to 20 feet high and not over two or three inches in diameter. A detailed discussion of the Forest-conditions of the Klondike will be furnished by Mr. Williams to an early number of the *Journal of the New York Botanical Garden.* Mr. G. N. Nash said there were 36 species of Grasses, 7 new, and some others new to North America, as *Calamagrostis Lapponica* and *Festuca altaica.* Professor Lloyd spoke of the interesting forms of *Lycopodium complanatum.* One in Montana and Idaho is irregular in habit, and has one spike on a peduncle. The Klondike specimens seem to be the Arctic condition of this Montana form and so agree with others from Labrador.

Edward S. Burgess,
Secretary.

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

The March meeting of the Science Club of the University of Wisconsin was a memorial session in honor of the late John Eugene Davies, a charter member of the Club and for more than thirty years a professor in physics in the University. From 1877 to 1890 Mr. Davies was in charge of the Wisconsin work of the United States Coast and Geodetic Survey. The base line of three miles which he measured, and upon which the triangulation system of the southern part of the State is based, has stood as a model of accuracy. Addresses were made by J. B. Parkinson, who gave a biographical sketch of Mr. Davies; by B. W. Snow, who spoke of physics in the University previous to 1891; by W. W. Daniells, who spoke of the sciences in the early days; by L. S. Smith, who discussed the work on the Coast and Geodetic Survey, and by A. S. Flint, whose subject was Dr. Davies' connection with the Washburn Observatory. At the close of the meeting the following resolution was unanimously adopted by a rising vote:

"In the death of Professor Davies the University has lost another of those teachers whose devoted services in the years following its reorganization were the foundation of its present prosperity. In the earlier years of his professorship he was obliged to teach many subjects and only to elementary classes. Yet in the distraction of these multifarious tasks, imposed by the necessities of a struggling institution, his love for the higher ranges of scholarship in his own department remained clear and strong. Throughout a professorship of more than thirty years he welcomed with eager interest every advance in mathematical physics and was in full appreciative sympathy with the development of that science, even in its remoter aspects. He loved his science for its own sake and was successful in imparting to his chosen students his own interest and pleasure in its pursuits. His kindly and serene personality endeared him to his associates, whether in the faculty or among the students. They desire by this minute to record their feelings of the loss in his death, both to themselves and to the University in whose service he spent his life."

A regular meeting of the Club held March 22d, was devoted to a symposium on the microscope and its use in the various departments of science. The following program was presented: Construction of the compound microscope and its use in physics, B. W. Snow; its use in general biology, E. A. Birge; in cytology, R. A. Harper; in bacteriology, H. L. Russell; in chemistry, S. M. Babcock; in petrology, Wm. H. Hobbs; and in engineering, J. G. D. Mack. An exhibition of the different types of instrument and of accessory apparatus served to illustrate the subjects presented.

William H. Hobbs.

CHEMICAL SOCIETY OF WASHINGTON.

The 116th regular meeting was held Thursday, February 8, 1900.

The following program was presented:

J. K. Haywood—'The Adulteration of the Arsenical Insecticides.'

C. A. Crampton and F. D. Simmons—'Uncompounded Chemicals under the War Revenue Act' (with exhibition of specimens).

Wirt Tassin—'The Relation of the Chemical Society to the Municipality.'

F. K. Cameron—'The Genesis of Hardpan.'

The 117th regular meeting was held Thursday, March 8, 1900.

The program was devoted to a symposium on Iron and Steel, as follows:

Iron—The raw material; chemistry of iron-ore smelting, cast iron, properties of iron.

Steel—The raw materials, converting methods, the mill, castings, forgings and plates, special steels.

The participants were Messrs. Dewey and Tassin.

William H. Krug,
Secretary.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

At the 516th meeting of the Society held March 31st at the Cosmos Club, Mr. Marcus Baker read an obituary notice of Samuel Shellabarger. Mr. H. S. Davis, by invitation, described the present 'State of Progress on the New Reduction of Piazzi's Observations.' This paper appeared in the issue of Science for April 13th. Mr. Alexander Macfarlane's paper on 'Vector Differentiation' was summarized and presented by Mr. Radelfinger, and finally Mr. Wead discussed the discontinuity in functions arising from an infinite exponent, and the use of such discontinuous functions to limit the range of a given equation: *e. g.*, to the surface within a circle and outside a square; to the black squares of a checkerboard; to the surface of a parallelopipedon, etc. The title of the paper was 'On certain Discontinuous and Indeterminate Functions.'

E. D. PRESTON.
Secretary.

DISCUSSION AND CORRESPONDENCE.

REQUEST FOR CO-OPERATION IN WORK ON THE COMING SOLAR ECLIPSE, ETC.

THERE is a very singular phenomenon observed during the moments immediately preceding and following total solar eclipses, that has, up to the present time never been satisfactorily explained so far as I know. Just before totality, usually about a minute before, alternate bright and dark bands are observed sweeping across the country. These have been called shadow bands by some observers, and diffraction bands by others. They can be observed to the best advantage by laying a large piece of white cloth on the ground.

In some eclipse reports they are styled 'Diffraction bands bordering the moon's shadow.' Fringes bordering a shadow should, however, move with the speed of the shadow. Observations show that the dark bands move quite slowly, from ten to twenty feet per second, while the shadow of the moon rushes across the country at cannon ball speed. Moreover, they move in one direction before the eclipse, and in the opposite direction after. The only half way plausible explanation that I have ever heard offered for the shadow bands is that they may be due to striæ in the atmosphere. This would bring them under the head of the scintillation phenomena treated of somewhat extensively in advanced works on optics, but I am unable to see how any such regular and symmetrical distribution of light and shade can result in this way. That the distance between the bands varies on different occasions lends some plausibility to this explanation, but it is not impossible that the width of the bands is a function of the location of the point of observation, that is to say of its distance from the center of the eclipse track. This can only be determined by numerous and extensive observations covering a wide tract of country, and it is to secure as many data as possible on this subject that I desire to secure the co-operation of all who are interested in the subject. Observations just outside of and just within the track of totality will be of especial interest. The observations can be made without any apparatus, and as the bands are not visible during totality, their observation will not inconvenience any who are more interested in the spectacular than in the scientific side. At the end of this article I shall outline as clearly as possible just how the observations should be made, and what data recorded. It has occurred to me that the stroboscopic disc may be of use in determining the cause of the bands. If a source of light produces in any way, moving bands of light and shade, it is obvious that if the eye be directed towards the source, it will receive more light from the source while a bright band sweeps across it, than during the transit of a dark band. If the alterations are not too rapid a fluctuation in the brilliancy of the source should be observed.

As a matter of fact, citing a special case, the bands are about three inches wide, and move with a velocity of about ten feet per second. This means that forty bands cross the eye every second, too many to cause any flickering effect. By means of a stroboscopic disc, which is merely a circle of cardboard with equidistant radial slits arranged to be rotated at varying speeds, it is possible to keep the eye in a dark or light band as long as we choose.

Suppose we are looking at the source of light through the slits of the revolving disc, and suppose that the speed of rotation is such that the slits cross the eye at the same rate that the dark and light bands do. This is practically keeping the eye continually in a dark or light band. If the rotation is a little faster or a little slower, the slits will alternately get into, and out of step with the bands, and the eye will be in a bright band one moment, and in a dark one the next. In this way we may make the speed of the fluctuations as slow as we please, and if we look at the sun's crescent through such a device we may possibly detect a flickering in whatever part of the source of light is operative in producing the bands. The disc should be about a foot in diameter with about eight slits in it, distributed uniformly. I should advise that three or four concentric rings of slits of different width be made, the eye being moved from one to another. In this way the apparent brilliancy of the sun can be varied at will, which would increase the chances of detecting the flickering if it existed. The location of the flickering is to be carefully noted, that is, whether it is of a portion, or the whole of the crescent, or whether it is in the air close to the edge of the sun's limb. The disc can be rotated by hand by means of a whirling table, to be found in every physical laboratory. This simple arrangement will, I think, be found more satisfactory than a more complicated rotator, as the speed is more immediately under one's control.

I am planning to use such an arrangement myself, and hope that some of the other eclipse parties can arrange for the simple experiment also. The speed and width of the bands could also be determined by means of the stroboscope. If we receive the bands on a white cloth on which a scale is marked, and view them through the revolving disc, by carefully adjusting the speed of rotation, it is obvious that the bands can be made to appear stationary. Their width can then be accurately determined by counting the number in a given distance, and the speed with which they move calculated, if the speed of the disc at the moment is recorded. In this way any change in width could be measured.

While these observations can only be made by persons who have had some training in work of this nature, valuable data may be secured by any who are fortunate enough to live within the eclipse belt. I desire to secure, if possible, a complete record of the appearance of the bands over the entire country, together with statements regarding the direction of the wind, condition of the air, etc. The bands can be best observed by spreading a sheet or other large white cloth on the ground. As soon as the moving shadows appear, which will probably be about a minute before totality, lay a lath on the sheet parallel to the shadows, with as great accuracy as possible. Then try to estimate the width of the bands, and the velocity with which they are moving, also the direction in which they are going, that is whether from east to west or west to east. The width of the bands can be best determined, I imagine (I have never seen them), by estimating the width of a group, say five or six, or as wide a bunch as the eye can grasp and follow with certainty as to the number of dark bands in it. A scale for reference, preferably a white board with feet and half-feet marked with strong black lines, will be of assistance. It should be laid perpendicular to the shadows, that is at right angles to the lath. The speed can be estimated by trying to keep up with the moving shadows, and may be recorded as slow walk, fast walk, slow run, etc. Those who are accustomed to counting quarter seconds, can probably make a fair estimate of the speed by noting the time of transit of a band across the sheet. The shadows will disappear at the moment of totality, but will reappear again as soon as the sun's edge emerges from behind the moon. A second lath should be laid on the sheet, parallel to the bands unless their direction is the same, and the same observations repeated, noting whether the direction of motion is reversed. After the eclipse is over, determine the direction of the two laths as accurately as possible with the compass, and measure the angle between them. Note the direction of the wind before and after the eclipse, and record the general atmospheric conditions.

Tabulate the data as follows:

Before Totality.

1. Direction of the bands.
2. Width of bands. (Give all data, that is, number of dark bands in given width of the system.)
3. Estimated speed. State how estimated.
4. Direction of motion. Whether from east to west, or west to east.
5. General appearance. Whether sharp or hazy, whether contrast between light and shadow is considerable. If possible estimate relative intensity of illumination in dark and light areas.
6. Direction of wind. Temperature and general atmospheric conditions.

After Totality.

Repetition of the above.

Actual angle between the laths.

General remarks, and location of point of observation.

Reports should be sent to Professor R. W. Wood, Physical Laboratory of the University of Wisconsin, Madison, Wis.

R. W. Wood.

A STATEMENT REGARDING THE SITUATION AT THE UNIVERSITY OF CINCINNATI.

To the Editor of Science:—Letters received by the writer from professional friends in various parts of the country indicate more than a passing interest in the university crisis at Cincinnati. The reason is not far to seek. The measure which has been here enacted shows that it is possible in the United States of America for nearly an entire college faculty to be summarily discharged without specific reason and without a hearing. This fact gives to a local trouble an aspect of national concern. The security of the tenure of office of every professor in the country is responsive to such a shock.

One is naturally inclined to shield from publicity a purely family trouble, but the common interest in the present case leads me to submit for the readers of Science a brief statement that may be of service to all who desire to find correct answers to several pertinent questions.

What is the explanation of this revolutionary procedure? Does the difficulty center in the Board of Directors, in the Faculty, or in the President? As one who has just resigned from the Faculty, after a term of service covering nearly seventeen years, I may seem in a measure disqualified to make an *ex parte* statement, but the demand is for facts rather than argumentation, and the main facts are best known to the Faculty.

A comprehensive view of the situation must embrace the Board, the Faculty and the President. I restrict my attention to the most salient features of these three phases of the main question.

The conditions as to each are somewhat exceptional. The Board of Directors consists, normally, of nineteen members, including, *ex officio*, the mayor of the city. They are nominated by the judges of the Superior Court. The term of office is six years. The members are generally men of considerable professional or business experience, but frequently without college training, or knowledge of university management.

The varied business of the Board is subdivided and referred to special committees, including a committee on finance, a committee on law, a committee on buildings, a committee on academic department, etc. While the final authority rests with the Board, the voice of each committee is practically decisive in its department. The members have seemed disposed to limit the expenditure of time and thought to the special duties assigned to them. The majority of them are seldom seen at the University even on great public occasions like commencement.

The educational horizon of members of the Board may be discerned from the following circumstance. The special committee in closest touch with the President met with a committee of citizens in order to confer concerning the present difficulty. The argument was advanced that the Board was acting strictly within its rights in the matter, inasmuch as it was simply a question of discharging and hiring employees. The changes contemplated were desirable, even from a business standpoint, since as good, or better men could be secured for less money.

During the twenty-five years which have elapsed since the organization of the university, the institution has been without a president.

The Dean of the Faculty has been charged with administrative functions and the deanship has been at times a rotary office. On several occasions a difference of judgment arose between the Faculty and members of the Board as to the internal administration. The Faculty took a positive stand, incurring thereby the displeasure of members of the Board. The depth and implacability of this feeling were never realized by the Faculty until the recent publication of a lengthy statement, drawn up by a special committee of the Board, in defense of their present course.

Again, the Faculty has received censure in not having been able always to act as one man in the government of the student body.

The reportorial mind has been quick to attribute any differences of opinion to personal ambitions and jealousies. I do not doubt the sincerity of members of the Board in asserting that many members of the Faculty strove to secure the deanship as a possible stepping-stone to the vacant presidency. This view is so far from the actual truth, however, as to be even grotesque. The deanship has long been a thank-less and most undesirable office. One member of the Faculty who held the office for several years, accepted it reluctantly after much persuasion.

The several difficulties above referred to were never of such moment as to interefere seriously with the steady development of the institution; the number of students increased continuously, a high standard was always maintained, and the good will of the community was manifested by benefactions of increasing frequency and magnitude. Never were such evidences of public appreciation so marked, as in the year ending with June, 1899, at which time the new president was elected.

The Faculty had long desired the guidance of a wise president, and to President Ayers the members at once extended the assurance of their cordial co-operation and support. This attitude was not reciprocated.

From the published statement of the special committee of the Board, we infer that the president had been fully imbued with the ideas of members of the Board who were opposed to the Faculty. He had asked and received almost absolute power. How he has used this power is known. He was made the sole channel of communication between the Faculty and the Board, and he has made himself the judge as to what communications should reach the Board. In more than one instance he has withheld from the Board orderly communications addressed to it, and duly entrusted to him for transmission.

The summary dismissal of the Faculty, in the face of excellent work accomplished and recorded year after year, raised a storm of public indignation. A committee of prominent citizens, numbering over twenty-five was organized and a subcommittee was then appointed to make a thorough investigation and report. This committee was hard at work for several weeks.

It is in evidence that in October, soon after the opening of the term, the President gave a dinner at his house to the members of the Board, and that on this occasion he asked and received pledges of support in whatever he might recommend in the way of changes in the Faculty.

Whatever may have been the advice given to the President, he seems to have surpassed all expectations. Members of the Board have expressed surprise and dissatisfaction, but under the circumstances they felt under obligation to support the new administration.

In conclusion, I refer, for the benefit of all who desire detailed information, to the 'Final Report of the Citizens' Committee on University Affairs' which will soon be issued in pamphlet form. A synopsis of the pamphlet is as follows:

1. Unauspicious opening of the college year.
2. Abrupt and sweeping demand for resignations.
3. Emphatic protest and peremptory resignation of Professor Myers in an open letter.
4. Public opinion finds expression in the organization of a citizens' committee which forms a subcommittee for investigation.
5. Report of subcommittee to the general committee of citizens. Much light thrown on the situation. The Faculty vindicated and President Ayers arraigned. The subcommittee instructed to appear in behalf of the Faculty at the next meeting of the Board.
6. Pleas for justice before the Board of Directors. A public hearing of the Faculty requested. A petition of the Faculty for an open investigation returned to the writers by reason of an alleged informality. Special committee of the Board appointed to draw up a reply to the citizens' committee and report at a special meeting. The minority denied representation.
7. The special committee of the Board makes an elaborate report. Indiscriminate accusations. General defense of the Board and of the President. The request of citizens refused. A hearing not granted.
8. Resignation of Professor French. The report accompanying the resignation not presented by the President, although addressed to the Board of Directors. The Board declines to hear the report when a demand therefor is made by one of its members.
9. Remarkable admissions by President Ayers.
10. The report of Professor French.
11. Review of the Board's defense.

Any one may obtain a copy of this pamphlet by addressing W. N. Hobart, 243 East Pearl street, Cincinnati, Ohio.

All official statements and reports, pertinent to both sides of the question, are given in full.

THOMAS FRENCH, JR.

CINCINNATI, April 10, 1900.

INFORMATION WANTED.

THE psychophysiology of anæsthesia is a productive subject greatly in need of adequate investigation and discussion. Both pure science and practical surgery have doubtless much to gain from a deeper-going study of experiences under ether, chloroform, nitrous oxide, etc., than has as yet been made. Scientific literature has frequently contained accounts of isolated individual experiences reported most often because of their strangeness. A very large number of descriptions of the ordinary experiences is what is now desired, and to this end blanks have been prepared on which replies to certain simple questions may be written. All persons, and especially hospital surgeons, officers of medical societies, and instructors in medical schools, are respectfully requested to send to the undersigned for as many of these blanks as they care to distribute among persons who have been under an anæsthetic. These will be gratefully sent, and received when filled out.

GEORGE V. N. DEARBORN.
PHYSIOLOGICAL LABORATORY,
HARVARD MEDICAL SCHOOL,
Boston, Mass.

NOTE ON THE PIGMENTS OF THE COCCID CHIONASPIS FURFURA, FITCH.

I HAVE just had occasion to examine some specimens of *Chionaspis furfura* sent me by Professor C. A. Keffer, from Tennessee, and in so doing, I found some pigments which may be of interest to others than coccidologists. The female *C. furfura* is brown-pink, but on being placed in liquor potassæ immediately becomes olive-green. The addition of hydrochloric acid at once restores the brown-pink color, showing that the two are simply acid and alkaline phases of one pigment, the living female having an acid reaction. These two colors are strikingly like those seen in the feathers of certain birds, namely the jacana, and the herons of the subgenera *Hydranassa* and *Butorides;* the resemblance being so close as to suggest that the maroon and green colors of these birds are likewise due to two phases of a pigment closely similar to that of the *Chionaspis.* The eggs of *C. furfura*, abundantly present in the material examined, are purplish-pink, with orange portions due to an oil or fat. The oil retains the same brilliant orange color even after boiling in caustic potash, but collects in globules varying from 6 to 60 μ diameter. The purplish-pink pigment is turned Prussian-green by liquor potassæ, but in a short while this again alters to a clear indigo blue. The latter change is hastened by boiling. On adding hydrochloric acid, the blue becomes reddish-purple. The egg-pigment is therefore similar to that of the mother insect, yet apparently not identical.

T. D. A. COCKERELL.
MESILLA PARK, NEW MEXICO, March 31, 1900.

CURRENT NOTES ON PHYSIOGRAPHY.

PORTO RICO.

R. T. HILL has prepared some 'Notes on the Forest Conditions of Porto Rico' (U. S. Dep't Agric., Forestry Bull. 25), which are prefaced by a description of the island's configuration and by a plate taken from a relief model. The discontinuous axial sierra, steeper to south than north and mostly of volcanic rock, is of rugged aspect, less than 3500 feet in height. The mountains do not rise to a single crest line, but form a sea of conical peaks and beaded ridges, elaborately dissected by numerous ravines and valleys between knife-edged spurs of graded slope. Here habitations find no place in the narrow valley floors but occupy the mountain sides, where heavy rainfall and deep-weathered tenacious soil support a luxurious vegetation; coffee and tobacco are cultivated to the very summits. The sierra is surrounded by a narrow and broken 'collar' of limestone, forming coastal hills of heights up to 500 feet or more, round or dome-like in form, with few ravines; here the surface is sheeted with a thin red argillaceous residual soil. South of the sierra, where the climate is relatively dry, the hills are mostly covered with thorny vegetation or chapparal. Longitudinal valleys sometimes separate the hills from the sierra; transverse valleys divide the hills into groups separated by wide alluvial floors which open into triangular plains (filled estuaries) occupied by sugar plantations on nearing the coast. A great part of the island has been cleared of its original forest. The 3268 square miles of the island contain 26,650 farms, which therefore average 7.4 to the square mile; but much land once cultivated, is now 'ruinate' from long use without fertilizers or from soil-washing.

The 'Water Resources of Porto Rico' are described by H. M. Wilson (Water Supply and

Irrigation Papers, U. S. Geol. Surv., No. 32, 1899).

THE DUNES OF GASCONY.

THE great belt of dunes that borders the straight coast of Gascony is well described by R. Le Mang (Deutsch geogr. Blätter, Bremen, xxii, 1899, 235–256). The dunes frequently rise 40 meters (one reaches 89 m.) over a belt 6 or 8 kil. wide and 240 kil. long. Near the sea the ridges lie north and south, parallel to the shore; further inland they trend east and west, parallel to the prevailing winds. The inland dunes have long been forested and stationary; the shore dunes were until recently barren and wandering. Fields and forests were buried and villages were overwhelmed by the advancing sand; the mouths of streams were blocked and shifted; lagoons were pushed inland with rising water level, invading and drowning fields and villages. Now, after many years of experimental effort and nearly a century of systematic work, the advancing dunes have been arrested. A half artificial dune or dike runs along the beach, with very gentle slope to the sea; here the wear of winter storms must be repaired during the succeeding summer. Next follows a protection zone, 300 to 1500 met., wide, covered with stunted firs and bushes, where the first strength of the sea wind is expended. Then comes the great artificial forest of firs and oaks, under whose cover the invasion of the dunes has entirely ceased.

THE MORVAN.

AN area of crystalline rocks, forming an upland known as the Morvan, a northern branch of the central plateau of France, was visited in the spring of 1899 by a party under the direction of M. Vélain, professor of physical geography at the Sorbonne; and a report of the excursion is made by M. Martonne, instructor in geography in the university of Rennes (Annales de Géogr., viii, 1899, 405–426, maps and photos.). The mesozoic strata that once covered the crystallines of this district more or less completely are now worn back so that the ancient crystalline floor is broadly revealed as a plateau, gently undulating where it has longer been exposed to erosion, remarkably even where recently uncovered; the harder members of the overlapping strata have retreated in strong escarpments that rim around the crystalline area on the east, north and west, while the less resistant members are reduced to plains between the scarped reliefs. A recent general elevation is indicated by the narrow valleys, frequently having incised meanders, by which the uplands and lowlands are alike dissected. The origin of the drainage is not especially considered; it appears to be in greater part the accordant with the general dip of the strata away from the Morvan center, and hence would be classed as originally consequent.

THE FLÄMING.

BETWEEN the mountains of middle Germany—Harz, Erzgebirge, Riesengebirge—on the south, and the Baltic lowlands on the north runs a belt of low uplands, underlain by some inequality of rock-floor and built up as a 'diluvial plateau' by the moraine of an early glacial epoch; now cut into disconnected parts by the broad valleys of glacial rivers. The Fläming is one of these uplands, lying east of Magdeburg between the Elbe and the Spree. It is recently described by E. Schöne (Beitr. zur Geogr. mittl. Deutschland, herausg. von F. Ratzel. Wiss. Veröffentlichungen Verein f. Erdkunde, Leipzig, iv, 1899, 93–194). The softly rounded hills are separated by ramifying dry valleys or 'Rummeln' which lead streams in wet weather. Faint terraces on the sloping valley sides are ascribed to stream action during the erosion of the valleys, although in a photographic illustration they closely resemble pasture paths, and indeed their modification by sheep is noted in the text. The steeper valleys on the northern slope of the Fläming have supplied gravel for the construction of a number of flat alluvial fans on the floor of the bordering glacial-river trough.

W. M. DAVIS.

BOTANICAL NOTES.

FOSSIL PLANTS OF THE BLACK HILLS.

A RECENT paper in the nineteenth annual report of the United States Geological Survey, entitled 'The Cretaceous Formation of the Black Hills as indicated by the Fossil Plants,' by Lester F. Ward, is of more than usual interest to the general botanist, since it is given over almost wholly to a discussion of the cretaceous flora of the region. Much space is given to the fossil cycads which have been found in abundance in several areas within the Black Hills. These are all referred to the genus *Cycadeoidea*, of Buckland, of which twenty-two species are described, twenty being new to science. The great majority of these were found in the Minnekahta region in the southern part of the Hills, the remainder occurring in the Blackhawk region on the eastern side. The fossil forests receive considerable attention also. These occur in the Minnekahta, Blackhawk, and Hay Creek regions, the latter on the northern side of the Black Hills. The systematic position of the trees here found as fossils, has not been determined, as the structure of the wood has been too much obscured in the process of silicification. One specimen of fossil wood turned out to be a new species of *Araucarioxylon*. Other fossil plants from the lower Cretaceous enumerated in this paper are, nineteen species of pteridophytes, twenty-six gymnosperms (in addition to those already mentioned), four dicotyledons, and six fruits of uncertain relationship. From the Dakota group there are, one pteridophyte and seven dicotyledons. One hundred and sixteen plates, several maps and a few wood cuts amply illustrate this interesting paper.

THE PHYSIOLOGICAL RÔLE OF MINERAL NUTRIENTS.

An important paper (*Bulletin* 18) by Dr. Oscar Loew of the Division of Vegetable Physiology and Pathology is devoted to the discussion of the physiological rôle of the mineral nutrients of plants. After an introductory chapter the rôle of phosphoric acid, iron compounds, hydrogen compounds, alkali salts, and calcium and magnesium salts are taken up in succession. A full review will appear later, this note being intended merely to call the attention of biologists to a paper which must prove to be of great value to them.

THE FOREST RESERVES OF THE UNITED STATES.

Henry Gannett, geographer to the United States Geological Survey, publishes in the nineteenth annual report a collection of papers on the forests of the West, especially of the forest reserves created by executive order of President Cleveland about four years ago (Feb. 22, 1896). It is a thick royal octavo volume of 400 pages, illustrated with 110 plates, most of which are fine 'half tones' from photographs. A thick packet of maps, also, accompanies the volume. A study of the illustrations and maps, alone, tells the tale of wanton waste, which has been characteristic of our treatment of the forest covering of our country from the beginning. The lumberman who is only anxious to get out the best trees with the least expenditure of time and money, caring nothing for the future of the forest, and the careless 'camper' who leaves his fire for the winds to spread through the forest, together are devasting the western forests, as they have the eastern. No one can glance over this volume and not feel indignant over the heedlessness shown by the people who take possession of the forest lands of the Nation. Here and there nature is making an effort to reforest the denuded areas, showing us what we might do easily in the way of preserving these forest areas for our children. These reservations came none too soon, and yet we remember with what bitterness the President was assailed by greedy lumbermen, and a certain class of politicians always eager to curry local favor.

We may quote one paragraph from the paper by John B. Leiberg on the forest conditions of northern Idaho. "There can be no doubt as to what the future will bring. The complete destruction of the forest in this region as a commercial factor is beyond question, unless the forest is placed at once under effective supervision. At the present time less than 40 per cent. of the burnt areas are reforesting, and sections carrying the young growth are reburned annually. Sixty per cent. are either in the brush stage or would be entirely barren but for small quantities of coarse grasses or weeds. These tracts will nearly all reforest in time, but to accomplish this result fires must be kept down. The forest conditions prevailing in northern Idaho merely foreshadow future forest conditions elsewhere in the wooded districts in the west."

A STUDY OF FUNGUS POISONS.

By the use of a number of deleterious agents, Mr. J. F. Clark was able to determine approximately their toxic effect upon the germination and development of certain fungi. His results were published in the November and December numbers of the *Botanical Gazette*. He used five common moulds, viz: *Aspergillus flavus*, *Sterigmatocystis nigro*, *Oedocephalum albidum*, *Penicillium glaucum* and *Botrytis vulgaris*, on account of their ability to grow normally under the conditions imposed by the experiments. Twenty-eight chemical substances were used, including half a dozen acids, eight hydroxids, three oxidizing agents, five sulfates of the strongly toxic metals, etc. A table of results is compiled, giving the coefficients of injury, inhibition, and death point. The author's summary includes many points, three of which we may quote, viz: "(1) Fungi are in general much more resistant to most deleterious agents than the higher plants. In the case of the mineral acids a concentration of from two to four hundred times the strength fatal to the higher plants is required to inhibit the germination of mould spores under favorable conditions. (2) Different species of fungi present great differences of resistance to many agents. Of the agents tested in this study, $NiSO_4$ permitted the greatest specific variation and dichloracetic acid the least. (3) Particular forms of the same species present very different powers of resistance, depending probably on previous environment."

Charles E. Bessey.

The University of Nebraska.

THE LABORATORY OF THE U. S. FISH COMMISSION AT BEAUFORT, N. C.

The laboratory of the United States Fish Commission, at Beaufort, on the coast of North Carolina, will be reopened for work on the first of June, and will remain open until October. The laboratory is designed for research in marine biology (zoology, botany, physiology), and, for the present, is open to men only. The collecting outfit is particularly good, including steam launch, sailboat, skiffs, dredges, trawl, seines, surface nets, etc. The indoor equipment embraces the usual apparatus, glassware, and reagents, provided by marine laboratories. The more important works on the systematic zoology and natural history of the forms that are found on this part of the coast, will be on hand; and the current numbers of the more commonly used journals will also be received. Naturalists working at the station will find a collection of identified forms, illustrative of the fauna and flora of the region, together with a record of breeding times and local habitat of the species.

Beaufort is a pleasant village to which a few people come for a quiet vacation. The collections of the earlier naturalists, and the work of the Marine Laboratory of the Johns Hopkins University, stationed here under Professor Brooks for many years, made known the interesting character of the fauna—which is exceedingly varied and abundant, including most of the forms described for the South Atlantic coast. Research at the laboratory is untrammeled, it being assumed that every occupant of a table will, in the course of his investigations, add to our knowledge of the natural history of this part of the coast. Inquiries and applications for tables, for which there is no charge, should be addressed to the Commissioner of Fish and Fisheries, Hon. George M. Bowers, or to the director of the laboratory.

H. V. Wilson,
Director of the Laboratory.

University of North Carolina,
Chapel Hill, N. C.

PROFESSOR DEWAR ON SOLID HYDROGEN.

We are able to print in the present number of Science an interesting address by Professor Dewar before the Royal Institution on his work on the 'Liquefaction of Hydrogen.' Professor Dewar has continued his researches and gave a further lecture before the Royal Institution on February 6th, an account of which we take from the London *Times*.

The theatre of the Royal Institution was crowded to its utmost capacity to hear Professor Dewar lecture on 'Solid Hydrogen.' Sir Frederick Bramwell was in the chair, and among those present were Lord Lister, Lord Rayleigh, Sir F. Abel, Sir W. Crookes, Sir B. Baker, Sir Henry Mance, Professor Odling, Mr. T. W. Swan, the Solicitor-General for Scotland, Dr.

Ludwig Mond, Professor S. P. Thompson, Professor Hellmann, and Mr. Fletcher Moulton, M.P.

Professor Dewar began with some remarks about the nature of hydrogen, pointing out that many of the most advanced chemical thinkers had regarded it as being metallic in character, and that to Professor Odling belonged the credit, so far as he knew, of being the first to suggest the contrary, now recognized to be the fact. Proceeding to show a long series of experiments, he explained how it was a consequence of the physical properties of liquid hydrogen that not much could be done with it unless it was available in reasonable quantities. After proving that its temperature was some 70 degrees below that of liquid air, and explaining how reduction of temperature became disproportionately more difficult the lower the starting-point on the scale, he illustrated the difference in the behavior of liquid nitrogen and liquid oxygen when made to boil under diminished pressure. The temperature of both was reduced, but, while the nitrogen became viscid and ultimately solid, the oxygen absolutely refused to solidify. In fact, it was impossible to get solid oxygen in this way, the reason being that at the lowest temperatures it had an inappreciable pressure of vapor, whereas that of nitrogen was considerable. To give an idea of the power of liquid hydrogen as a cooling agent he performed an experiment depending on the same principle as Wollaston's cryophorus, with the difference that the fluid to be solidified was not water but liquid air containing a large proportion of nitrogen, while the material used to effect condensation was liquid hydrogen. He next showed how hydrogen could be liquefied in a closed tube, explaining the importance of this fact with regard to the determination of its density and other questions, and then exhibited the gas in the solid form. This result was effected by putting a portion of the liquid into a vacuum vessel isolated from heat as perfectly as possible. When the pressure in the vessel was slowly reduced, the hydrogen was suddenly seen to appear like a white mass of solidified foam, possessing the lowest steady temperature it was possible to obtain at present—viz, 258° below zero Centigrade, or 15° on the absolute scale. The fact that hydrogen did solidify in this way was in a sense a disappointment to any one who was anxious to reach very low temperatures, for a solid was a bad substance for cooling purposes. Coming to the uses of liquid hydrogen for scientific research, Professor Dewar first showed how it afforded the only means of obtaining solid oxygen. Another important application was to the separation of the more volatile gases of a mixture. The behavior of metals with regard to electrical conductivity at very low temperatures was a very interesting question. From experiments with liquid air it was expected that at the zero of absolute temperature pure metals would have no electrical resistance at all. But although the resistance curves appeared to be going straight to zero at the temperature of liquid air, he found that lower down, below the temperature of solid air, they bent sharply round, so that a finite resistance was indicated. In conclusion, Professor Dewar acknowledged the kindness of those who had contributed to the cost of these investigations, and paid a tribute to the skill and devotion of his assistants. Such researches were necessarily costly, but he could not share the view of those who suggested that the results would not be worth the cost.

X-RAYS AND PHOTOGRAPHIC PLATES.

A DISCOVERY of very great practical interest in X-ray work has been made by Professor Nipher at Washington University. He has discovered that when photographic plates are exposed to the light of an ordinary room for a few days, that they may still be used for taking X-ray pictures. If while the Crookes tube is acting on the plates they are still exposed to the ordinary light of a room, they develop as positives. The shadows are dark. If they are in a plate holder when exposed to the X-ray, the pictures are like those formed in the ordinary way, and they are apparently as clearly defined.

The advantage of the method is that the plates may be developed by the light of a lamp. The developer (hydrokinone) being weak and cool, the process may go on for an hour if desired, and all the details may be studied as they appear. In this way, details which are sometimes obscured by over-development may be seen as they appear, although they might not show in the fixed negative.

The development of such plates in darkness is liable to fog the plates. If plates do fog, they may be cleared up by taking them nearer to the lamp.

The results will be published in a forthcoming number of the *Transactions* of the Academy of Science of St. Louis.

SCIENTIFIC NOTES AND NEWS.

The usual spring meeting of the Council of the American Association for the Advancement of Science, was held at Washington on April 19th, with President Gilbert in the chair. Dr. Howard, the permanent secretary, read his report. The local secretary for the New York meeting reported that all the arrangements for the meeting were made, and that everything promised an unusually large and successful meeting. The number of important special societies meeting with the Association would be much larger than ever before. The sessions will be held at Columbia University except the address of President Gilbert, which will be given at the American Museum of Natural History. The Hotel Majestic, Central Park and 72d St., will be the headquarters of the Association.

President Seth Low, of Columbia University, was elected president of the American Geographical Society, New York City, on April 17th, succeeding the late Charles P. Daly.

M. A. Lancaster, director of the Meteorological Service of Belgium, has been elected a foreign member of the Royal Meteorological Society, of London.

Mr. Wm. G. Freeman, B.Sc., has accepted the position of technical assistant to the Imperial Department of Agriculture for the West Indies.

Cambridge University will confer the degree of doctor of science on Mr. Charles Hose, of Saráwak, known for his contributions to the natural history of Borneo.

Professor Frederick Starr has returned from a three month's trip to Mexico.

The Duke of Loubat has returned to New York from a trip in Mexico, where he visited the ruins of Mitla to view the explorations by Mr. Marshall H. Saville, of the American Museum of Natural History.

Mr. Andrew Carnegie has promised the trustees of the Carnegie Institute, Pittsburg, Pa., to become responsible for $3,000,000, the amount estimated as necessary for the proposed extension and enlargement of the building at the entrance of Schenley Park. The new building will be nearly six times as large as the present one. It will be 500 x 700 feet in size. The space now occupied by the museum will be transferred to the library, while the museum will be transferred to the new building.

M. Alphonse Milne-Edwards, the distinguished French naturalist and director of the Museum of Natural History, died on April 21st, in his sixty-fifth year.

Professor Wm. M. Thrasher, for forty years professor of mathematics at the Northwestern Christian University and Butler College, has died at Berkeley, Cal.

A correspondent of the London *Times* writes: Captain Peter Astte Scott, R.N., who died on March 31st, at the age of 84, had had a long and varied career. He joined the Navy in 1829, served in the Antarctic expedition of 1839 under Sir James Ross, and only missed serving as lieutenant to his old friend Sir John Franklin in his last fatal Arctic expedition owing to his arrival in England too late. He had already served five years under that officer in Tasmania as naval architect and surveyor. From 1846 to 1866 (when he retired) he was employed on the marine survey of the Canadian Atlantic coast. From 1869 to 1889 he served in the marine department of Canada, the protection of the fisheries, as examiner for masters' and mates' certificates, and as general nautical adviser, and was well known to all who served on the North American station for his geniality and hospitality.

The London *Times*, also, states that Mr. William Cross, the well-known naturalist and dealer in wild animals, has died at Liverpool, after an illness lasting several weeks. He was 57 years of age. As a collector of rare and curious animals Mr. Cross was without a rival, and probably no name was so well known in the remote regions where wild beasts are hunted and captured as his. His place of business in Earle street, not far from the Liverpool Exchange, was always full of strange and interesting beasts, and had a fame which probably no similar collection for purposes of trade has ever enjoyed. Here proprietors of zoological colletions and travelling menageries and all persons interested in animals and reptiles could count on finding objects worthy of attention, and here all importers of wild animals brought their wares. In addition to his chief establishment in Liverpool Mr. Cross had branches in Africa, America and China. He carefully studied all the living creatures brought under his notice, and was not only able to estimate their value from a commercial point of view, but also knew the best methods of treating them in captivity. Besides his large stock of animals Mr. Cross collected all sorts of curiosities, such as china, weapons, skins, and rare shells.

THE Arctic steamer *Windward* will sail from New York, in July, under American registry, by virtue of a bill recently signed by President McKinley. It will be under the command of Capt. S. W. Bartlett, of Newfoundland, who commanded the *Diana* and the *Hope.* The movements after joining Lieut. Peary, who is wintering in Etah, will be determined by him.

THE Minnesota Botanical Society was given preliminary organization at a meeting held in Minneapolis, April 14, 1900. Thirty-four members of the committee on organization were declared fellows of the Society, and a committee on constitution was appointed to report to the Fellows in June.

A CALL signed by Dr. Hexamer, President of the Farmers' Club of the American Institute; Dr. N. L. Britton, Director of the New York Botanical Garden, and James W. Withers, of *American Gardening*, has been issued for a meeting to be held in the museum building of the New York Botanical Garden, Bronx Park, for the purpose of organizing a 'New York Society of Horticulture.'

WE learn from *Nature* that the summer meeting of Cambridge University will be held on August 2–15th, and August 15–27th. Among the lectures to be delivered in the section on scientific progress are the following: *Physical Science:* The development of the nebular theory in the nineteenth century, by Sir Robert Ball, F.R.S.; The spectroscope in astronomy, by Mr. Arthur Berry; The wave-theory of light, by Sir George Stokes Bart, F.R.S.; Advances in the science of electricity, by Professor J. J. Thomson, F.R.S.; The conservation of energy, by Professor J. A. Ewing, F.R.S.; Chemistry and its applications, by Mr. M. M. Pattison Muir; Electro-chemical methods, by Mr. D. J. Carnegie. *Biological Science:* The theory of evolution and its influence on thought and research, under arrangement; Researches on the brain, by Dr. Alex. Hill. There will also be lectures on some aspects of advance in the following sciences: Geology, by Professor T. McK. Hughes, F.R.S.; Anthropology, by Professor A. Macalister, F.R.S.; Agriculture, by Professor W. Somerville; Bacteriology, by Professor Sims Woodhead. Mr. H. Yule Oldham will give a lecture on Geographical exploration in the nineteenth century; Professor W. M. Davis of Harvard University, will give six lectures On the study of the development of land forms. The study of special points in the following departments will be undertaken in sectional meetings: Chemistry and physics, under the direction of Mr. A. W. Clayden; Evolution, under the direction of Mr. F. W. Keeble, Mr. C. Warburton, and others; Anthropology, under the direction of Professor A. C. Haddon, F.R.S. There will in addition be arranged, primarily for teachers, practical courses in chemistry and geography.

THE National Educational Association's special committee charged with the inquiry into the proper seating, lighting, heating and ventilating of the school buildings, offers a prize of $200 for the best essay submitted on each of those topics, and of $100 for the second best essay. Each essay shall be limited to ten thousand words and shall be submitted in printed or typewritten copy without signature, but with the name of the author enclosed with it in a sealed envelope and addressed to the chairman of the committee at Emporia, Kans. Three copies of each essay shall be submitted. They must be mailed not later than February 1, 1901.

THE Glasgow International Exhibition to be opened in May, 1901, includes eight classes, embracing agriculture, mining, industrial design and manufactures, machinery and labor-saving appliances in motion, locomotion and transport, marine engineering and shipbuilding, lighting and heating, science, education, music, sports and sporting appliances. Applications for space should be made to the General Manager, Mr. H. A. Hedley, not later than June 1st.

THE news regarding the plague is not reassuring. It continues unabated in India, the deaths numbering over 4000 a week. A total of 185 deaths is reported from Manila and 38 from Sidney. Deaths still occur in Mauritius, and cases are now reported at Aden on the Red Sea.

THE *Annales de l'Institut Pasteur* states that since the foundation of the Antirabic Institute at Algiers 1836 persons have been under treatment, of whom 645 belonged to the province of Algiers, 632 to that of Oran, 557 to Constantinople and two to Tunis. Out of this total, 1339 were French, Spaniards and Europeans of other nationalities, while 497 were Algerians. The number of deaths has been only nine, or rather less than one-half per cent.

THE Passmore Edwards Museum, in the Rumford-road, Stratford, is, according to *Nature*, now approaching completion and arrangements for the opening will shortly be made. The museum has been built and furnished by the Council of the County Borough of West Ham, at a cost of about 9000*l.*, of which 4000*l.* was the gift of Mr. Passmore Edwards. The main portion of the museum will be devoted to the Essex Museum of Natural History, belonging to the Essex Field Club, which is deposited in the building under agreement between the club and the Borough Council. The remainder of the building will be used as an educational museum in connection with the adjoining Municipal Technical Institute. The scientific control of the Essex Field Club collection remains with the club, and they contribute 50*l.* a year towards the curatorial expenses, the council contributing 100*l.* a year. The club appoints the curator. At their meeting on March 27th, the council resolved to set aside annually out of the Estate Duty Grant the sum of 1000*l.* for museum purposes. It is expected that from 500 to 600*l.* of this will be needed for the upkeep and maintenance charges, the balance being placed to the credit of a museum purchase fund, which will be treated as a capital fund, from which payments may be made from time to time for the purchase of objects and of the necessary cases, etc., in which to exhibit them. The Essex Field Club have appointed Mr. W. Cole as curator of their Natural History collections. The building itself, and the educational collections of the council, are under the charge of the principal of the Technical Institute, Mr. A. E. Briscoe.

MR. H. W. NEVINSON writes to the London *Daily Chronicle* from Ladysmith under siege, as follows: Again I was on Observation Hill two or three times in the day. It is impossible to keep away from it long. Whilst Puffing Billy was firing I tried to get sight of a small mocking bird, which has learned to imitate the warning whistle of the sentries. In the Gordons the Hindoo Purriboo-Singh, from Benares, stands on a huge heap of sacks under an umbrella all day and screams when he sees the big gun flash. But in the other camps, as I have mentioned, a sentry gives warning by blowing a whistle. The mocking bird now sounds that whistle at all times of the day, and what is even more perplexing, he is learning to imitate the scream and buzzle of the shell through the air. Another interesting event in natural history occurred a short time ago up the Port road. A Bulwan shell, missing the top of Convent Hill, lobbed over and burst at random with its usual din and circumstance. People rushed up to see what damage it had done, but they only found two little dead birds—one with a tiny hole in her breast, the other with an eye knocked out. Ninety-six pounds of iron, brass, and melinite, hurled four miles through the air, at unknown cost, just to deal a true lovers' death to two sparrows, which are sold for one farthing.

The New York *Evening Post* states that the exhibit of the division of forestry for the Paris Exposition is now complete and on the way to Paris. It will be one of the most novel of the government exhibits and will be wholly distinct from the commercial features of lumbering to be shown in another department. The display will be in the form of a hall or pagoda, the walls of which consist of large transparencies illustrating American forest conditions. These walls will be double and illuminated by interior electric lights. The pictures range in size from 3 by 5 feet to 4 by 6 feet. There will be two transparencies 6 by 10 feet, portraying groves of red fir and California big trees, two of the most impressive American trees. A point will be made of the relation of forestry to agriculture, and such subjects as protective forests, the use of trees in preserving water supply, the management of woodlands, etc., are fully illustrated. The extent of the timber resources of the United States will be shown by pictures from all important lumber regions. The distribution of forests will be shown by maps. Twenty of the most important American woods will be represented by sections of trees.

Mr. Wm. Dutcher writes in the *Auk* that Commission houses in New York City, in their endeavor to obtain bird skins for millinery purposes, send out many circulars offering varying scales of prices for bird skins. Recently a postal card was sent by one of these firms to postmasters along the Gulf coast soliciting Gulls, Terns, Grebes, Barn Owls, etc. Dr. T. S. Palmer, of Washington, brought this matter to the attention of the Hon. Jas. Wilson, Secretary of Agriculture, who at once sent a very urgent letter to Hon. Chas. Emory Smith, Postmaster General, calling his attention to this direct violation of the law, and a letter has been sent to postmasters warning them against being parties to any transactions that violate the State laws.

The automobile contests which will take place at Paris during the exposition period are exciting much interest. The speed contests will take place in July. In the contest between carriages there will be nine cash prizes, aggregating 30,000 francs. The first prize will be 8000 francs; the second prize, 6000 francs. In the contest between small carriages there will be seven prizes, aggregating 9000 francs, the first prize being 4000 francs. In the contest between motocycles there will be thirteen cash prizes, aggregating 8000 francs, the first prize being 2000 francs and the second prize 1500 francs. The contest between light-weight automobiles will take place in September. The program will include a contest of automobile cabs and delivery wagons capable of carrying loads of 1200 kilograms in weight. United States Commissioner General Peck has taken great interest in these automobile contests and will offer every facility for American visitors who desire to witness them.

One of the innovations in military transportation, says the *Electrical World*, which was brought about and developed largely through our war with Spain is the use of the automobile. The signal corps of the American army has recently been supplied with electric automobile wagons for use in the Philippines. These wagons are of two kinds, one to carry the instruments and material and the other to carry the personnel. The first is built like a covered ambulance, with rubber-tired wheels, and contains a storage battery capable of running the vehicle for thirty hours on one charge when carrying 1500 pounds of load. There are two $3\frac{1}{2}$-H.-P. motors, one in each rear wheel. The maximum speed is about ten miles an hour. The other wagon is constructed like a high cart and is in other respects similar to the first. Both wagons are fitted with electric side lights, and the first also has electric lights in the interior. Other military applications of the automobile have been considered by the military world, but this is the first actual introduction.

At a recent meeting of the Sanitary Institution, London, the annual report of the council was presented, stating that the question of additional premises for enlarging the museum and extending the work of the institute had received the careful consideration of the council, and although the leases of the present premises had been renewed for another ten years these were scarcely adequate, and it had been decided to start a building fund, a proposal which was looked upon with favor by the president, the Duke of Cambridge. They had allotted £5,000 of the invested capital of the Institute as a nucleus of the fund and further donations had been received, but some £25,000 was expected to be required. Many lectures and demonstrations on sanitary science had been given to the students, who, during the period over which the lectures had extended, had had the free use of the library and museum, and the committee desired to tender hearty thanks to the lecturers. Two new examinations had been established during the year, one for inspectors of meat and other foods, and the other in practical hygiene for school teachers. There had been a steady increase in the number of students brought to the museum by lecturers and demonstrators, showing an appreciation of the teaching value of the museum. The total in 1899 was 2154, against 1958 in 1898 and 1674 in 1897. A comparison of the roll of the institute with that of the preceding year showed an increase in the number of members and associates, the total in 1899 being 2324, against 2130 in 1898.

UNIVERSITY AND EDUCATIONAL NEWS.

Dr. D. K. Pearson, of Chicago, on April 14th, which was his eightieth birthday, decided to add $525,000 to the $2,000,000 he has given to colleges. His principal gifts, to be paid before January 1, 1901, will be: Mount Holyoke College (Mass.), $150,000; Colorado College (Colorado Springs), $50,000; Berea College (Ky.), $50,000; Fairmount College (Kan.), $50,000; McKenzie College (Ill.), $25,000; Onarga College (Ill.), $20,000; Carleton College (Minn.), $50,000; Fargo College (N. D.), $50,000.

The will of Mrs. Eliza Chrisman, who died in Topeka recently, has been filed in the Probate Court. She bequeaths the greater part of a fortune, estimated at $250,000, for the founding of the University of Topeka. The bequest is contingent on the Methodist churches of Kansas raising an equal amount within ten years. Mrs. Chrisman leaves $35,000 cash to the Ohio Wesleyan University.

Mr. John D. Rockefeller some time since promised $100,000 to Denison University, at Granville, O., if the trustees should raise $150,000 this term. President Purinton has announced that nearly $125,000 had been secured.

The establishment of a School of Commerce at the University of Wisconsin, Madison, was unanimously decided upon by the board of regents at their meeting on the 17th ult. Professor W. A. Scott is made director of the school, and a professor of commerce is to be appointed.

At the Patrons' Day celebration of Colgate University on April 20th, the annual address was delivered by President Seth Low of Columbia University, New York, who took as his subject, 'The College and the University.'

It is now said that Dr. E. Benjamin Andrews will probably accept the chancellorship of the University of Nebraska.

Eighteen fellowships have been awarded at Columbia University, of which the following are in the sciences, falling more immediately within the scope of this Journal:

Hartley Burr Alexander, Philadelphia, Pa., Philosophy, University of Nebraska, A.B., 1897.

Robert Henry Bradford, Salt Lake City, Utah, Metallurgy, University of Utah, B S., 1895.

William Austin Cannon, Palo Alto, Cal., Botany, Stanford University, A.B., 1899.

Robert Heywood Fernald, Cleveland, O., Mechanical Engineering, University of Maine, B.M.E., 1892.

George Irving Finlay, New York, Geology, Harvard University, A.B., 1898.

Thomas Jesse Jones, Greenfield, O., Sociology, Marietta College, A.B., 1897; Columbia University, A.M., 1899.

Austin Flint Rogers, Lawrence, Kan., Mineralogy, Kansas State University, A.B., 1899.

Harry Beal Torrey, Berkeley, Cal., Zoology, University of California, B.S., 1895, and M.S., 1898.

Clark Wissler, Columbus, O., Psychology, Indiana University, A.B., 1897; A.M., 1899.

Dr. A. Osann, docent in geology in the University at Bâsle, and Dr. M. Smoluchowski von Smolan, docent in theoretical physics in the University at Lemberg, have been promoted to assistant professorships. Dr. Fünfstück, docent in botany in the Polytechnic Institute at Stuttgart has been made full professor. Dr. Ed. Buchner, professor at the Agricultural Station of Berlin, has qualified as docent in the University.

SCIENCE

FRIDAY, MAY 4, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE MEDICAL SCHOOL OF THE FUTURE.*

AMONG the intellectual movements that have characterized the century now drawing to a close there is perhaps no one more deserving of careful study than that which is concerned with providing education for people in the school, the academy and the university. The importance of popular education became apparent in proportion as political freedom was secured for the people. Thus Viscount Sherbrooke, better known as the Hon. Robert Lowe, in the reform debates of 1866 and 1867, after the passage of a bill for the extension of the suffrage, uttered the well known words: "We must now at least educate our masters." The same sentiment has also more recently been embodied in the inscription on the Boston Public Library. "The Commonwealth requires the education of the people as the safeguard of order and liberty," and in the presidential address of Dr. J. M. Bodine,† at the meeting of the Association of American Colleges in 1897 we find the same idea thus expressed, "In America the citizen is king. The king must be educated to wield aright his ballot-sceptre."

For many years educators looked upon their work with no little complacency. The educational systems of the various civilized

*Address by the president before the Fifth Triennial Congress of American Physicians and Surgeons given at Washington on May 2nd.

†*American Practitioner and News*, June 26, 1897.

countries were supposed to be well adapted to the ends in view, and educational exhibits have been generally regarded as important features of international expositions. But within the memory of most of those now before me signs of serious discontent have not been wanting. Education has not always been found to furnish the required safeguards for order and liberty. Highly educated men have often been found singularly lacking in mental balance. Schools for the inculcation of 'common sense' have never yet been established. Even the great development of psychology as an experimental science, which has occurred chiefly within the last twenty-five years, though it has served to establish many laws of mental action, has thus far failed to justify the hope that pedagogy may find in psychology a foundation for the erection of rational systems of education. Indeed we have recently been told by one of the ablest expounders of this science that it is a great mistake for teachers to "think that psychology, being the science of the mind's laws, is something from which they can deduce definite programs and schemes and methods for immediate schoolroom use. Psychology is a science and teaching is an art. A science only lays down lines within which the rules of the art must fall, laws which the follower of the art must not transgress: but what particular thing he shall positively do within those lines is left exclusively to his own genius."*

Even this general guidance has been very imperfectly afforded, for the limits set by the science of psychology to the art of teaching have never been precisely defined. In fact the most fundamental question of all, viz, the relation of mental to physical development has not yet been settled, though much material for its study has been collected. It is not therefore surprising that in many countries teachers have made too great demands upon the time and strength of growing children.

* W. James, 'Talks to Teachers,' p. 7.

This has been clearly the case in some parts of Germany where schoolboys from eight to fifteen years of age have found their vital energy so far exhausted by the school work required of them that they have lost all inclination for vigorous athletic amusements so naturally indulged in by Anglo-Saxon boys. The deterioration of the race as a result of too close application to intellectual pursuits, to the neglect of the physique, has been fortunately obviated, in the case of Germany, by the army system which takes entire possession of the youth before it is too late and, by requiring him to devote three years to the education of his body, turns him out, at the end of that period, a young man with mind and body, trained to a high degree of efficiency, well fitted for civil as well as military pursuits and comparing favorably in all respects with men of his age in other nations. Looked at from this point of view the German army must be regarded as an important part of the educational system of the country though as a piece of educational machinery its workings cannot be considered economical. In fact the absurdity of depending upon the army to remedy the defects of the school system has long since been forced upon the attention of German educators and the difficulties above alluded to are now in a fair way to be removed.

In our own country difficulties of quite a different kind have been met with. Here the great danger which threatens our system of popular education arises from its close association with party politics. The office of a school committee man in one of our large cities has been well described as "the smallest coin in which politicians pay their debts," and as long as the education of our children continues to be entrusted largely to men who consider their position on a school board as the lowest step of the political ladder, there is small hope of the adoption of rational methods of education. Moreover this intimate alliance between education and politics greatly aids the efforts of persons more zealous than discreet to direct the instruction of children in accordance with their own special views. Thus nearly all the states of the union have upon their statute books laws requiring the physiological action of alcohol to be taught to children in all grades of the public schools. These laws violate the first principles of pedagogy inasmuch as the physiological action of a drug cannot possibly be understood without a familiarity with anatomy, physiology and chemistry which school children cannot be supposed to possess. They have been passed at the bidding of total abstinence associations, sometimes in opposition to the earnest protests of the teachers entrusted with their execution. How these excrescences upon our educational system may be best removed and the work of instruction placed under the control of those best qualified to direct it are questions demanding serious consideration.

I have mentioned these instances in which great educational systems have been found wanting merely for the sake of pointing out that the critics of our methods of medical education, who, as Professor Exner* has shown, are now raising their voices in every land, do but give a special expression to a wide spread feeling that our educational systems are not accomplishing all the objects for which they have been devised, and that the discontent which they imply is but a healthy dissatisfaction with the results thus far accomplished. May the time be far distant when those in charge of our educational interests shall rest content with what they have achieved, for this will indicate that a state of stagnation has been reached similar to that which characterizes the institutions of the Celestial Empire, and that no further attempt is to be made to adapt our methods of instruction to the constantly widening domain of human knowledge and experience.

* *Wiener Klinische Wochenschrift*, 1900, No. 3.

It may, perhaps, be well for me at this point to offer a few words in explanation of the selection of such a well-worn theme as medical education as the subject of my remarks this evening. It is true that in recent years the subject has been a favorite one with those who have been called upon to address medical associations or classes of graduating students, and if, in spite of this fact, I venture to add another address to the fast growing literature of the subject, my justification may be found in the following reasons: In the first place it must be borne in mind that such addresses are very quickly forgotten "Were it not so," as Dr. Billings has remarked, "it would be a hard world for address-givers." In the second place, the progress of medicine at the present time is so rapid that new points of view are constantly being secured, and it is, therefore, not at all impossible that, even at comparatively short intervals, new and valuable suggestions may be made both with regard to subjects to be taught and to methods to be employed in giving the instruction.

Lastly, it so happens that during the academic year, now nearly completed, the faculty of the Harvard Medical School has inaugurated an entirely new plan of instruction in the sciences of anatomy, physiology and pathology. This scheme, though still in the experimental stage, embodies ideas of such fundamental importance in medical education that its presentation to a representative body of the medical profession seems to me to be peculiarly appropriate.

I shall, therefore, ask you to consider with me this evening what lessons the faculty of a modern medical school may draw from recent advances in medical science and recent experience in medical education or, in other words, on what lines the instruction of a medical school of the first rank is likely, in the immediate future, to be organized. I say in the *immediate* future for what changes are in store for us in the course of the next few decades it is equally impossible to foresee and useless to speculate.

RELATION OF MEDICAL SCHOOLS TO UNIVERSITIES.

One of the most hopeful signs of the times in the field of medical education is the growing tendency of the better schools to ally themselves to universities and of universities to establish medical departments. Of the great advantages to medical education which may be expected from this union it is unnecessary for me to speak, for they formed the subject of a thoughtful discourse delivered by the last president of this congress at Yale University in 1888.* The twelve years that have elapsed since he spoke have brought accumulating evidence of the soundness of his views. In fact, it is difficult to see how a private medical school of the joint stock company type can ever, in the future, rise to the first rank, for such a school is not much more likely to attract endowments than a cotton mill, and without endowments the enormous expenses of a modern first-class medical school cannot possibly be met.

Great as are the benefits to a medical school of thus forming a department of a great university, the advantages of the union are not wholly on one side. Besides the increase of prestige secured to the University by the broadening of its functions, the establishment of a medical school as part of the university organization greatly facilitates the instruction of those students who, without any intention of becoming physicians, seek in the study of the medical sciences a means of general culture and mental discipline.

* *New Englander and Yale Review*, Sept., 1888.

The relations between the governing body of a university and its medical faculty in matters of administration are often defined by custom and tradition rather than by statutory provisions, and vary considerably in different institutions. In general, two methods of government may be distinguished. Either the initiative is left with the teaching faculty, the governing body exercising simply a veto power, or the governing body acts directly without necessarily asking advice from the faculty or its members. The former method of government is most likely to be found in those cases in which a well-established medical school has allied itself to a university for the sake of the mutual benefits that may ensue from the union, and the latter method in those cases in which a university has completed its organization by the creation of a medical department. Both methods have certain advantages and neither is without its drawbacks. In all cases men are more important than methods. On the one hand, the collective judgment of a teaching faculty on matters relating to medical education, is likely to be of more value than that of a governing body which may not, and generally does not, include physicians among its members. On the other hand, personal and selfish considerations are perhaps more apt to sway the judgment of a faculty than that of a body of trustees, especially when the question is that of the appointment of teachers. That this is not a serious danger, however, the experience of Germany seems clearly to show, for in that country, as Dr. Farlow has recently pointed out, the faculty 'has more power in regard to appointments and the general policy of the university'* than with us, and yet we find there the custom of calling professors from one university to another, fully established; a custom which

* Presidential address. Am. Soc. of Naturalists, Dec., 1899. SCIENCE, Jan. 5, 1900.

must be regarded as one of the strongest influences in maintaining a high standard of educational efficiency. On the whole, therefore, even with this possibility of error, the judgment of a faculty would seem to be the safer guide, and there are probably few boards of trustees who would feel themselves justified in disregarding it altogether.

The above-mentioned advantages of a union between a medical school and a university will naturally become more obvious as the problems of medical education become more complex, and the methods of instruction more costly. Hence we may expect in the near future to find all of the better class of medical schools under the ægis of a university, and we may reasonably hope that this change will be associated with a diminution of the total number of medical schools now so greatly in excess of the needs of the country.

The union of a medical school with a university at once compels the consideration of the proper relation between the academic department and the professional school. To say that the former should be the feeder of the latter and that the holding of an A.B. degree should be the condition of admission to professional studies, is to adopt the position taken by two of our leading medical schools. The A.B. degree, however, since the introduction of the elective system, no longer stands for a definite amount and kind of training. Hence the Johns Hopkins Medical School demands not only the diploma, but also evidence of ability to read French and German and of laboratory training, in physics, chemistry and biology. The Harvard Medical School is content to accept the A.B. diploma as evidence of fitness to pursue professional studies, stipulating only that the holder shall possess an adequate knowledge of inorganic chemistry. Whether the example set by these schools will be generally followed is quite doubtful. Without undervaluing the importance of collegiate training as a preparation for a professional career it may perhaps be contended that a properly conducted admission examination is a better test of fitness to pursue the study of medicine than the possession of a diploma the value of which varies so much with the character of the college bestowing it. Moreover, the possibility that a young man, unable to afford the expense of a college course, may yet by private study prepare himself for a professional career is not to be lost sight of. Hence the Harvard school provides for the admission by special vote of the faculty of young men, not holders of an A.B. degree, who may furnish satisfactory evidence that they have obtained an equivalent education and that they are consequently able to profit by the instruction which the school has to offer.

The recent lengthening of the course of study, from three years to four, in all the best medical schools of the country, has drawn renewed attention to the importance of enabling the student who takes the A.B. degree as a preparation for medicine, to so far shorten the sum total of the time devoted to his education, that he may be able to enter upon the work of his profession at an age not in excess of that at which his European confrères begin their career as practitioners. A few years ago an examination of the best accessible evidence on the subject led to the conclusion that foreign systems of university education enabled students of medicine to enter upon their life-work at least two years earlier than was possible for the alumni of Harvard College, a condition dependent upon the fact that the changes in the academic department, which had raised the age of graduation, had been made with little regard to the interests of the professional schools, and chiefly for the purpose of making the undergraduate department as complete as possible in itself. In other universities a similar condition existed, though probably not in the same degree, as in Harvard.

That the American medical student, seeking the best possible preparation for his profession, is seriously handicapped by these conditions has been generally recognized, and the question of the best method of meeting the difficulty has been widely discussed. The most thorough treatment of the case consists in reducing the academic course to three years. Less radical methods are the provision in the academic department of courses of instruction by which students may anticipate a part of their professional work, and the permission to count the first year of a professional course as the fourth year for the bachelor's degree. The first and most radical method meets with strenuous opposition, owing to the deeply-rooted traditions which surround the four years' academic course in this country, while the other plans violate what in some colleges seems to be regarded as an educational axiom: that one course of study should not count toward two degrees. It is interesting to notice that, without any specific legislation to this end the quiet working of the elective system has, in Harvard College, practically solved the problem by bringing about a condition in which, as President Eliot says:* "Any young man of fair abilities can now procure the degree in three years without hurry or overwork, if he wishes to do so or his parents wish to have him." The President further ventures to predict that "within a time comparatively short, the majority of those who enter the Freshman class will come to college with the purpose of completing the requirement for the degree in three years." As soon as a three years' residence becomes the rule rather than the exception, a young man spending four years in college will, of course, be regarded either as deficient in mental capacity or as having wasted his time.

That a reduction of the academic course to three years is an advantage to students looking forward to a professional career, or to further study in a graduate school is too obvious to need discussion, but it is interesting to find the change advocated in the interest of the undergraduates themselves. Professor Clement L. Smith, for nine years Dean of Harvard College, points out* that there is a large and influential class of college men who get into the habit of frittering away their time simply because they have so much of it and that "for them and for those whom they influence—and these make up the largest part of the class we are now considering, the men who go from college into active life—the reduction of the course would be a distinct gain." Nor need we fear (as has sometimes been urged) that, in thus reducing the length of the college course, we shall lose the fourth and most valuable year, for as Professor Smith says: "The senior year is the best year, not because it is the fourth, but because it is the last year. The causes which make it what it is come from before, not from behind; from the consciousness of opportunity passing away and of the serious problems of life close at hand. The period of waste lies between the fresh zeal and good resolutions with which the youth begins his course, and the growing sense of responsibility with which he draws near its close. It is this intermediate period that would be shortened, in the briefer course. It is not the senior year that would be cut off; it is rather, let us say, the sophomore year, and with it might well go its absurd name."

It thus appears that the claims of the college and of the professional school upon the time of the student are in a fair way to be harmoniously adjusted.

* Annual reports of the president and treasurer of Harvard College, 1898–99, page 10.

* The American College in the Twentieth Century, Clement L. Smith, *Atlantic Monthly*, Feb., 1900.

THE ELECTIVE SYSTEM.

Let us now consider in what way the medical school of the immediate future is likely to differ from that of the present time with regard to the subject matter of instruction. The most striking phenomenon presenting itself to the educator of to-day is the recent enormous widening of the educational horizon. "The immense deepening and widening of human knowledge in the nineteenth century and the increasing sense of the sanctity of the individual's gifts and will power "* are the fundamental facts which underlie the development of the elective system, but it is important to bear in mind that, as Professor Smith observes,† this development has been "due not so much to increase of knowledge—for not all new knowledge is straightway fit for educational purposes—but rather to the conversion of new fields of knowledge to the uses of education."

A discussion of the elective system of education with its attendant advantages and dangers would require far more time than I have at my disposal and I must content myself with pointing out the possibility that, in this period of transition, the educational pendulum may have swung to an extreme position and that too much attention has been given to the accidental differences of pupils while the essential similarity of their natures has been lost sight of. In discussions on individuality as a basis for the elective system one sometimes hears the statement (attributed to Leibnitz) that no two leaves of the same tree are alike. This dissimilarity however, does not prevent them from all elaborating the same sap and it is, moreover, always associated with sufficient essential similarity to enable any one, with even the most elementary knowledge of trees, to distinguish the leaves of an oak from those of a maple.

* C. W. Eliot, *Atlantic Monthly*, Oct., 1899, p. 443.

† C. L. Smith, *Atlantic Monthly*, Feb., 1900, p. 219.

While admitting that some of the extreme positions now maintained by the advocates of the elective system may, in the future, have to be abandoned, no one can doubt the wisdom of adapting the education to the powers of the mind to be educated and of allowing, in the case of advanced students, the choice of the individual to be a determining factor in the selection of studies. Let us, therefore, enquire to what extent the elective system may properly find a place in the curriculum of our medical schools. That it forms an essential feature of our postgraduate schools of medicine scarcely needs to be mentioned, for these schools have been organized for the express purpose of enabling graduates in medicine to select such subjects for study as may seem to them desirable and to acquire more advanced knowledge than was possible in the undergraduate course. Moreover, in some of our larger schools, since the establishment of the compulsory four years' course, a portion of the instruction of the fourth year has been given in elective courses in various specialties. The elective system in medicine is, therefore, not altogether a novelty, and the question now before us is whether it may be profitably extended to the earlier years of the course.

In his remarks at the dinner of the Harvard Medical Alumni Association in 1895, President Eliot used the following language: "There ought to be in the Harvard Medical School an extended instruction far beyond the limits of any one student's capacity. This involves, of course, some optional or elective system within the school itself, whereby the individual student should take what is, for him, the best four years' worth, the faculty supplying teaching which it might take a single student eight, twelve or twenty years to pursue."*

One year ago last December, in an address which I had the honor to deliver in

* Bulletin Harv. Med. Alumni Assoc., No. 8, p. 40.

New York before the American Society of Naturalists,* I gave the reasons which seemed to me conclusive in favor of this extension of the elective system and, with your permission, I will take the liberty of presenting as briefly as possible the views there set forth.

In the first place it may be assumed that a medical school of the first rank should be an institution in which the most advanced instruction in all departments of medicine can be obtained, and on this assumption it is, of course, impossible to arrange a course of study that every student must follow in all its details, for, in the time which may properly be devoted to a course of professional study, it is quite impossible for even the most intelligent students to assimilate all the varied information which such a school may be reasonably expected to impart.

It seems, therefore, to be evident that in arranging a course of medical study a distinction must be made between those subjects which it is *essential* that *every* student should know and those subjects which it is *desirable* that *certain* students should know, that is, between those things of which no man who calls himself a physician can afford to be ignorant and those which are important for certain physicians but not for all; in other words, provision must be made both for required and for elective studies. The task of drawing the line between the essential and the desirable in medical education will require the greatest possible good judgment and readiness for mutual concession on the part of those engaged in the work, but there is no reason to fear that the difficulties will be found insuperable when the importance of the change has once been recognized.

Any one who is familiar with the existing methods of medical instruction is aware that in nearly every department many things are taught which are subsequently found to be of use to only a fraction of those receiving the instruction. Thus the surgical anatomy of hernia is taught to men who will subsequently devote themselves to dermatology, future obstetricians are required to master the details of physiological optics and the microscopical anatomy of muscles forms a part of the instruction of men destined to a career as alienists. Now no one can doubt the propriety of including instruction on all these subjects in the curriculum of a medical school, but it may be fairly questioned whether every student should be forced to take instruction in them all.

To better indicate the nature of the reform which I am advocating, allow me to describe a possible arrangement of a course of study in the department of physiology, with which I am of course more familiar than with any other. An experienced lecturer will probably find it possible to condense into a course of about forty or fifty lectures all the most important facts of physiology with which every educated physician must necessarily be familiar. Attendance upon these lectures, combined with suitable courses of text-book instruction and laboratory work, would suffice to guard against gross ignorance of physiological principles. In addition to this work, all of which should be required, short courses of not more than eight or ten lectures each, should be provided, giving advanced instruction in such subjects as the physiology of the special senses, cerebral localization, nerve-muscle physiology, the internal secretion of glands, the physiology of the heart, circulation and respiration, the digestive secretions, the reproductive organs, etc. These courses should be elective in the sense that no student should be required to take them all. Each student might, however, very properly be required to choose a certain number of

*See Science, N. S., Vol. VIII., No. 209, p. 921 and *Boston Med. and Surg. Journal*, December 29, 1898.

courses, which, when once chosen, become, for the student choosing them, required courses leading to examination. There is in my opinion, no doubt that an arrangement of instruction similar to that here suggested for physiology could be advantageously adopted in the departments of anatomy, histology, bacteriology, medical chemistry, pathology, surgery, and in the courses of instruction in the various special diseases, such as dermatology, ophthalmology, etc.

In the existing state of medical education the introduction of the elective system in some form or other seems to be an essential condition to any further important advance, for the curriculum of most of our schools is already so crowded that no considerable amount of instruction can possibly be added. Various arguments may, of course, be advanced in opposition to the change. It may perhaps be urged that no choice of studies can be made without determining to some extent the direction in which the work of a future practitioner is to be specialized and that such specialization cannot be properly and safely permitted until the student has completed his medical studies. To this it may be answered that, whatever may be the dangers of too early specialization, the dangers of crowding the medical course with instruction of which many students do not feel the need, and of thus encouraging perfunctory and superficial work, are a certainty no less serious. It is, moreover, a matter of common observation among teachers in medical schools that a certain number of students very early make up their minds either that they will become surgeons, obstetricians, or specialists of some sort, or, on the other hand, that they have a strong aversion to certain branches of medicine and a determination never to practice them. For such students a prescribed curriculum necessarily involves great loss of time and energy.

If it be said that under this system the medical degree will cease to have the definite meaning now attached to it and that it will be impossible to tell from his diploma in what way a physician has been educated, it may be replied that, though the degrees of A.B., A.M., Ph.D. and S.D. are affected with exactly this same uncertainty of signification, their value seems in no way diminished thereby. As long as the M.D. degree stands for a definite amount of serious work on medical subjects, we may be reasonably sure that those who hold it will be safe custodians of the health of the community in which they practise.

If it be urged that the elective system in medical education will lead to the production of a class of physicians who, owing to the early specialization of their work, will be inclined to overrate the importance of their specialty and to see in every disease an opportunity for the display of their special skill, it may be pointed out that this result is apt to be due not so much to early as to imperfect instruction in the work of a specialist, and that since the elective system tends to encourage thoroughness in special instruction, the evil may be expected to diminish rather than to increase.

METHODS OF INSTRUCTION.

Having thus recognized the necessity of remodeling our conception of the subject matter to be taught and noted the importance of distinguishing between the essential and the desirable in medical education we must next consider by what methods the needed information may be best imparted and the necessary training secured. There is perhaps no way in which modern educational methods differ more from those of an earlier period than in the greater prominence given to object lessons. Beginning with the kindergarten the child is trained to cultivate his power to observe accurately and to manipulate skilfully and, through his school and college life, prominence is given to the objective side of education to an extent which would have seemed to the book-trained pedagogues of a former generation but ill adapted to provide the well-stored mind which it was thought to be the principal object of education to secure. In the professional schools also the reaction against purely didactic methods has been strongly felt. Even in those professional pursuits to which the object method might seem at first sight least applicable, in the study of the law, the so-called 'case method' of instruction has been found to exert a vivifying influence.

In medical education in this country it is interesting to note that, in the very beginning, the instruction was more objective in its character than at a somewhat later period. In those early days it was in the office of his preceptor and at the bedside, as his actual assistant, that the embryo physician was initiated into the mysteries of his calling. Then followed a period when it was clearly perceived that the trained mind is necessary to interpret the data of observation and that mental training is essential to correct observing. Hence schools were established to provide this training by means of systematic didactic lectures covering all the departments of medicine and usually extending over not more than four months. These schools were intended at first merely to supplement the work of the preceptors but in process of time the relative importance of these two educational agencies was reversed and the work of the preceptors, became supplementary to that of the schools. The function of the preceptors finally became so subordinate that their names no longer appeared in the catalogues though this did not always indicate that they had ceased to afford students opportunities for practical clinical work.*

*See address by Henry Hun, M.D., *Albany Medical Annals*, October, 1896.

The schools, once established, grew chiefly by an increase in the length and number of the lecture courses as new and important subjects forced themselves upon the attention of the medical profession. Against this undue extension of purely didactic methods of instruction a reaction has now set in and during the last ten or fifteen years loud voices have been raised in advocacy of more objective methods than those at present in use. It is not, however, the reinstatement of the preceptor that is urged but rather the greater use of laboratory methods in the strictly scientific departments of medical instruction and their application as far as possible at the bedside of the patient. A fruitful discussion of the relative advantages of the laboratory, the lecture and the text-book as methods of medical education cannot be undertaken without a recognition of the fact that this education has a double object. In the first place the faculties of the student are to be so trained that he may observe carefully, reason correctly, study effectively and judge wisely; in other words, he is to be 'trained for power' to use President Eliot's phrase. In the second place there must be imparted to him a sufficiently large fraction of the acquired medical knowledge of the time to make him a safe custodian of the health of the community. Which of these two objects is the more important is a question which we need not now discuss, but even if we grant all that is claimed by the advocates of training for power it is evident that the constantly increasing range of subjects with regard to which an educated physician must be informed will greatly reduce the time which, in the curriculum of a medical school, may properly be devoted to courses of instruction not intended to impart direct and valuable information. In fact, 'training for power' should be largely a function of the academic department of a university, and, when undertaken in a professional school, should be so directed as to impart at the same time the greatest possible amount of useful information.

Let us now consider how far the didactic and the laboratory methods of instruction are each adapted to secure these two objects of medical education. For the purpose of training for power no one can doubt the value of the laboratory method. Contact with the phenomena themselves and not with descriptions of them has a stimulating effect upon the mind of a student, the importance of which it is difficult to exaggerate, but it does not follow from this that the lecture, the recitation and the text-book are worthless as methods of training. It is here that some of the advocates of laboratory methods have committed what appears to me a serious error such as is too apt to characterize all reform movements, the error, namely, of assuming that because one proposition is true, another proposition, not logically inconsistent with it, must be untrue. "These gentlemen," as Professor Howell* has expressed it, "having become possessed of the golden truth that the best knowledge is that which comes from personal experience, seem disposed to deny all value to knowledge communicated from the experience of others." We are told, for instance, by Dr. Burr,† that the didactic lecture "dates from the time when printing was unknown and manuscripts were rare and almost priceless and the only means of communicating knowledge was by word of mouth. To-day it is in large part an anachronism, because the time devoted to it could be put to better uses."

In his able address‡ at the last Yale University Medical Commencement my colleague, Dr. C. S. Minot, expressed himself as follows: "The very best that can be said of a lecture or a book is that it describes well the knowledge which someone possesses. There is no knowledge in books. * * * A book or a lecture can serve only to assist a man to acquire knowledge with lessened loss of time. Knowledge lives in the laboratory; when it is dead we bury it decently in a book. * * * A lecture is a spoken book." I venture to believe that Professor Minot's students will hardly agree with this estimate of the lifeless character of either his written or his spoken instruction.

In place of these rather disparaging views of the importance of a didactic lecture, I am inclined to accept Dr. Weir Mitchell's* opinion that "The best lecturing does not so much think for you as invite you to think along suggested lines of enquiry." If, as has been claimed, "the passive attitude of listening does not demand of the students intelligent thought,"† the fault must lie with the lecturer and not with the method of instruction. In every department of medicine advanced instruction necessarily deals with subjects which lie within what Foster has called the 'penumbra' of solid scientific acquisition, and about which conflicting views are, therefore, certain to be held. It is in inviting thought, with regard to the evidence on which these views rest, that the experienced lecturer has his best opportunity to train the minds of his hearers. Other opportunities are also afforded by the historical presentation of subjects about which differences of opinion no longer exist, for there are few things more instructive than to follow up, step by step, the lines by which our knowledge has advanced, noting

* *The Michigan Alumnus*, Jan., 1900, Vol. VI., p. 143.

† *Philadelphia Medical Journal*, Oct. 21, 1899.

‡ SCIENCE, July 7, 1899.

* *University Bulletin*, Vol. III., p. 85. Phila., Dec., 1898.

† W. B. Cannon, A.M. The Case Method of Teaching Systematic Medicine. *Boston Med. and Surg. Journ.*, Jan. 11, 1900.

the marks which distinguish the paths which have been trodden successfully from those which have turned out to be 'No Thoroughfare.' Even better opportunities for mental training than those which the lecture room presents, are afforded by the recitation, for here the minds of the teacher and the pupil are brought most closely into contact, the pupil's difficulties are appreciated by the instructor, and the point of view of the teacher can be learned by the pupil. It has always seemed to me that no higher enjoyment falls to the lot of the teacher than that which he experiences when, by a series of carefully considered questions, he leads his pupil onward from the known to the unknown, and notes the gleam of intelligence which illumines his countenance as a subject, previously obscure, becomes clear, as a result of his own mental operations, guided by his teacher's skilful questions. It thus appears that no monopoly of opportunities for mental training can be claimed for the laboratory method of instruction.

We must next inquire: what are the relative advantages of the laboratory and didactic methods as means of imparting information? Here we at once perceive that a great deal will depend upon the kind of information to be imparted. Certain subjects are much better adapted than others to be taught in the laboratory. The student of anatomy, for instance, can secure the greater part of the information which he needs by laboratory methods, *i. e.*, in the dissecting room, though a short course of lectures on descriptive anatomy in which an experienced teacher emphasizes the salient features of the subject will probably always be indispensable. Physiology and pathology (including physiological chemistry, pharmacology and bacteriology) are subjects in which laboratory instruction may be unquestionably much more freely used than is customary at the present time. The recent experience of the Harvard Medical School, in which the laboratory courses in these subjects have been greatly extended, has furnished conclusive evidence of the value of this method of instruction as a means both of imparting information and of stimulating the mind of the student. It must be remembered, however, that, as Dr. Welch* has said, "laboratory methods are extremely time-taking and are not adapted to teach the whole contents of any of the medical sciences. It is, of course, hopeless to attempt to demonstrate practically all of even the more important facts that the student should learn."

Moreover, observed facts are often apparently inconsistent with each other. Equally competent observers differ in their interpretation of them. Yet, because the last word of science has not been spoken on these subjects, it would be a mistake to exclude them from the medical curriculum. The student should rather be carefully instructed as to researches which have not yet yielded definite results. The most profitable way of reconciling conflicting observations should be pointed out, and he should be shown in what direction the search for truth can be prosecuted with the best prospect of success. He will then be able to appreciate the value of new observations and to assign to their true position the reported discoveries in medical science.

Instruction of this sort can, of course, be given only by an experienced lecturer who has mastered the subject of which he treats. It is in this kind of teaching and in the exposition of those facts and principles which cannot properly be made the subject of laboratory instruction to students that the didactic lecture of the future will probably find its principal field of usefulness. In the latter direction, however, the field is

* Higher Medical Education and the Need of its Endowment. *The Medical News*, July 28, 1894.

more restricted than might, at first sight, appear for the amount of practical work that can be successfully performed by first- and second-year students in a physiological or in a pathological laboratory is surprisingly large. In the physiological department of the Harvard Medical School, for instance, during the current academic year each pair of students in a class of 180 has been furnished with a kymographion, a capillary electrometer, a moist chamber, an induction coil, unpolarizable electrodes, etc., and the most important experiments of nerve-muscle physiology have been successfully repeated. The fundamental experiments in the physiology of the circulation, respiration, etc., are to be performed in a similar manner. In the pathological laboratory the students, working in sections of ten, have had an opportunity of producing for themselves and studying experimentally the most important pathological degenerations. They have also studied in the same way the principal infectious diseases. In the anatomical department also, while the number of didactic lectures has been diminished, the whole class has had largely increased facilities for the practical study of bones and of various special organs.

Still, after making due allowance for the legitimate expansion of laboratory teaching, it is probably safe to say that a systematic course of lectures in each of the medical sciences will never be found to be superfluous and that the day is probably far distant when the lectures will be merely 'explanatory of the experiments.'*

We have thus far considered the relative advantages of didactic and laboratory methods in teaching the medical sciences, but the agitation in favor of objective teaching has extended also to the clinical departments of medicine and the organization of 'clinical laboratories,' in which the cases of hospital patients may be studied by the most refined methods of physiological and pathological research, is a natural outcome of this agitation. In fact, however, so far as instruction is actually given at the bedside, clinical medicine has always been taught by means of object lessons. In many of our schools this instruction has been supplemented by so-called 'conferences,' exercises in which a student reports before the class a case which he has himself examined, giving diagnosis, prognosis and treatment. The subject is then discussed by the class and finally by the instructors.

Wherever actual cases of disease are thus utilized for teaching purposes the instruction is always likely to be more or less haphazard and unsystematic, for the diseases studied will be those of which actual cases happen to be available. To remedy this difficulty it has been recently proposed * to substitute the study of hospital records of cases for the examination of the cases themselves, a method quite analogous to that known as the 'case-method' which has long been used with great success in training students in the Harvard Law School. It will thus be possible to group cases so that they will throw light upon each other and, though the student will miss the stimulus of contact with the actual patient, the method presents so many distinct advantages that it will doubtless commend itself to many teachers of clinical medicine and of theory and practice.

It is thus evident that the reaction against purely didactic methods of instruction is well under way. It is a movement to be heartily welcomed, for there can be no doubt that medical students have been and still are too much lectured, but, like all other reforms, it should be carefully guided lest useful as well as useless things be swept away. It should be borne in mind that it

* Porter, *Boston Med. and Surg. Journal*, Dec. 29, 1898.

* W. B. Cannon, A.M., l. c.

is quite as easy to abuse the laboratory as the didactic method of instruction and that in all schemes of education a good teacher with a bad method is more effective than a bad teacher with a good method. As Professor Howell * has well remarked, "courses of lectures, that, if analyzed would be found to be top-heavy and lopsided, and otherwise possessed of an instability that should have insured failure, have been saved and made instruments of great value by the mere earnestness of the teacher."

DISTRIBUTION OF WORK.

The next question which I shall ask you to consider is that of the proper distribution of the work of a medical student. Thirty years ago no such question seems to have presented itself to the minds of instructors in medicine. The medical faculties of that time contented themselves with providing, each year, courses of lectures covering all the departments of medicine, as they were then understood, and every student was expected to attend as many of the lectures as he saw fit. Between 1870 and 1880 the fact that there is a natural sequence in medical studies became generally recognized and graded courses of instruction were established in the principal medical schools of the country. The grading, was not, however, carried sufficiently far. Thus instruction in both anatomy and physiology was generally given simultaneously through the whole of the first year, though the knowledge of structure should logically *precede* a study of function.

The time seems now to have come for taking another step in grading medical instruction and, during the academic year now drawing to a close, instruction in the Harvard Medical School has been given in accordance with a plan of which the guiding principles are concentration of work and sequence of subjects. Thus in the first half of the first year the students devote themselves exclusively to the study of anatomy including histology and embryology. In the second half year they are occupied with physiology, including physiological chemistry, while in the first half of the second year pathology, including bacteriology, engages their attention. It is perhaps too early to pass a final judgment upon the value of the method but thus far both teachers and students seem to regard it as a success. The result seems to have justified the opinion of its advocates that the work of the student would be made 'easier by concentrating his thoughts upon one subject instead of dissipating his attention upon many subjects.'* Nor have its opponents found any justification for their fears that the average brain would become fatigued and unreceptive by too close application to one subject for the sciences of anatomy, physiology and pathology 'are not narrow hedged in areas but rather broad and diversified domains composed of many contiguous fields,'† in passing from one to another of which the student may rest his mind without interrupting the continuity of effort essential to effective work.

An obvious objection to this method of concentrating instruction is the large amount of work which it imposes upon the instructors. There is no doubt that the labor of teaching every day in the week may task the powers of even the most enthusiastic instructor, but it has been found that the laboratory work which has occupied from two to three hours every forenoon has been conducted with much less fatigue than was anticipated. In fact students, when supplied with printed directions for work and with the necessary apparatus, need remarkably little supervision. In the physiological laboratory it was found that one instructor could readily supervise

*l. c., p. 144.

*Minot, l. c., Reprint, p. 22.

†Porter, l. c., Reprint, p. 12.

the work of fifteen pairs of students, and the experience in the anatomical and pathological departments was of a similar sort.

EXAMINATIONS.

Closely connected with the questions of method of instruction and of distribution of work is the subject of examinations. With regard to these tests of our educational methods, opinions vary even more widely than with regard to the methods themselves. There is only one point, as Professor Exner has remarked, on which teachers are practically united, and that is, "that an examination is a necessary evil." Every examiner knows only too well that an examination is but a very imperfect test of knowledge, but few are ready with any suggestion of a substitute. Much of the confusion which prevails in the discussion of this subject would be removed if the objects to be secured by an examination were more clearly apprehended. Professor Exner* points out that examinations may be broadly divided into two classes, viz, the *Controlprüfung*, to test the faithfulness with which the student has performed his daily tasks, and the *Reifeprüfung* to determine the amount of his permanently acquired knowledge of medical subjects.

The examination, which, at the end of the year, covers the whole ground of the previous twelve months' instruction and which is so common in our schools, belongs to neither of these two classes and is really a concession to a very natural wish of the students to get the examination 'out of the way' while the subject is still fresh in their minds. Having little justification from an educational point of view we may hope to see it abandoned when the extension of laboratory methods provides in the notebook and graphic records of each student the evidence of his daily work, and thus either renders a further examination unnecessary or prepares the way for a final test of his fitness to receive his diploma of M.D. Whether the written or the oral examination affords the better method of applying this test is a question about which opinions vary. The fact that some persons can write more readily than they can talk, while others can talk more readily than they can write, seems to be a reason for providing a mixed method of examination in which each individual may have an opportunity of appearing to the best advantage.

*l. c., Reprint.

CONCLUSIONS.

If the views here presented are well founded we may expect that a medical school of the first rank will, in the immediate future, be organized and administered somewhat as follows:

I. It will be connected with a university but will be so far independent of university control that the faculty will practically decide all questions relating to methods of instruction and the personnel of the teaching body.

II. It will offer advanced instruction in every department of medicine, and will therefore necessarily adopt an elective system of some sort, since the amount of instruction provided will be far more than any one student can follow.

III. The laboratory method of instruction will be greatly extended, and students will be trained to get their knowledge, as far as possible, by the direct study of nature, but the didactic lecture, though reduced in importance, will not be displaced from its position as an educational agency.

IV. The work of the students will probably be so arranged that their attention will be concentrated upon one principal subject at a time, and these subjects will follow each other in a natural order.

V. Examinations will be so conducted as to afford a test of both the faithfulness with which a student performs his daily work and of his permanent acquisition of medical knowledge fitting him to practise his profession.

If I have clothed these conclusions in the language of prophecy it is because the title of my discourse has laid this necessity upon me. In forecasting the immediate future, I have borne in mind the history of the immediate past and, if I have failed to read aright the indications of the lines on which our medical schools are to advance, it must be remembered that the development of a biological science and of its dependent arts not infrequently takes place in totally unexpected directions, thus introducing into the path of educational progress perturbations which may well defy prediction.

H. P. Bowditch.
Harvard Medical School.

NATIONAL STANDARDIZING BUREAU.*

Treasury Department,
Office of the Secretary,
Washington, April 18, 1900.

Sir: I have the honor to submit herewith the following draft of an amendment to the sundry civil bill, now pending in the Committee on Appropriations, and to recommend that the necessary appropriation to carry the same into operation and effect may be included therein:

That the Office of Standard Weights and Measures shall hereafter be known as the National Standardizing Bureau, and shall remain under the control of the Secretary of the Treasury.

The functions of the bureau shall consist in the custody of the standards; the comparison of the standards used in scientific investigations, engineering, manufacturing, commerce, and educational institutions with the standards adopted or recognized by the Government; the construction when necessary of standards, their multiples, and subdivisions; the testing and calibration of standard measuring apparatus; the solution of problems which arise in connection with standards; the determination of physical constants, and the properties of materials when such data are of great importance to scientific or manufacturing interests and are not to be obtained of sufficient accuracy elsewhere.

The bureau shall exercise its functions for the Government of the United States; for any State or municipal government within the United States, or for any scientific society, educational institution, firm, corporation, or individual within the United States engaged in manufacturing or other pursuits requiring the use of standards or standard measuring instruments. All requests for the services of the Bureau shall be made in accordance with the rules and regulations herein established.

The officers and employees of the bureau shall consist of a director, at an annual salary of six thousand dollars; one physicist, at an annual salary of thirty-five hundred dollars; one chemist, at an annual salary of thirty-five hundred dollars; two assistant physicists or chemists, each at an annual salary of twenty-two hundred dollars; two laboratory assistants, each at an annual salary of fourteen hundred dollars; two laboratory assistants, each at an annual salary of twelve hundred dollars; one secretary, at an annual salary of two thousand dollars; one clerk, at an annual salary of twelve hundred dollars; one clerk, at an annual salary of one thousand dollars; one messenger, at an annual salary of seven hundred and twenty dollars; one engineer, at an annual salary of fifteen hundred dollars; one fireman, at an annual salary of seven hundred and twenty dollars; one mechanician, at an annual salary of fourteen hundred dollars; one mechanician, at an annual salary of one thousand dollars; one mechanician, at an annual salary of eight hundred and forty dollars; one watchman, at an annual salary of seven hundred and twenty dollars, and two laborers, each at an annual salary of six hundred dollars.

The director shall be appointed by the Presi-

* Letter from the Secretary of the Treasury, transmitting, with accompanying communications, a draft of a bill for the establishment of a National Standardizing Bureau.

dent, by and with the advice and consent of the Senate. He shall have the general supervision of the bureau, its equipment, and the exercise of its functions. He shall make an annual report to the Secretary of the Treasury, including an abstract of the work done during the year, and a financial statement. He may issue, when necessary, bulletins for public distribution, containing such information as may be of value to the public or facilitate the bureau in the exercise of its functions.

The officers and employees provided for by this act, except the director, shall be appointed by the Secretary of the Treasury, at such time as their respective services may become necessary.

The following sums of money are hereby appropriated: For the payment of salaries provided for by this act, the sum of thirty-four thousand nine hundred dollars, or so much thereof as may be necessary; for the erection of a suitable laboratory, of fireproof construction, for the use and occupation of said bureau, including all permanent fixtures, such as plumbing, piping, wiring, heating, lighting, and ventilation, the sum of two hundred and fifty thousand dollars; for equipment of said laboratory, the sum of twenty-five thousand dollars; for a site for said laboratory, to be approved by the visiting committee hereinafter provided for and purchased by the Secretary of the Treasury, the sum of twenty-five thousand dollars, or so much thereof as may be necessary; for the payment of the general expenses of said bureau, including books and periodicals, furniture, office expenses, stationery and printing, heating and lighting, expenses of the visiting committee, and contingencies of all kinds, the sum of ten thousand dollars, or so much thereof as may be necessary, to be expended under the supervision of the Secretary of the Treasury.

For all comparisons, calibrations, tests, or investigations, except those performed for the Government of the United States or State governments within the United States, a reasonable fee shall be charged, according to a schedule submitted by the director and approved by the Secretary of the Treasury.

The Secretary of the Treasury shall from time to time make regulations regarding the payment of fees, the limits of tolerance to be attained in standards submitted for verification, the sealing of standards, the disbursement and receipt of moneys, and such other matters as he may deem necessary for carrying this act into effect.

There shall be a visiting committee of five members, to be appointed by the Secretary of the Treasury, to consist of men prominent in the various interests involved, and not in the employ of the Government. This committee shall visit the bureau at least once a year, and report to the Secretary of the Treasury upon the efficiency of its scientific work and the condition of its equipment. The members of this committee shall serve without compensation, but shall be paid the actual expenses incurred in attending its meetings. The period of service of the members of the original committee shall be so arranged that one member shall retire each year, and the appointments thereafter to be for a period of five years. Appointments made to fill vacancies occurring other than in the regular manner are to be made for the remainder of the period in which the vacancy exists.

I transmit herewith a statement of the conditions which call for the establishment of a national standardizing bureau, together with a few of the resolutions adopted by scientific bodies and the opinion of individuals as to the immediate and urgent need of such an institution.

Respectfully,

L. J. GAGE,
Secretary.

THE SPEAKER OF THE HOUSE OF REPRESENTATIVES.

CONDITIONS WHICH NECESSITATE THE ESTABLISHMENT OF A NATIONAL STANDARDIZING BUREAU.

The selection and care of the original standards, and the solution of problems involved in the production, calibration, and distribution of duplicates, constitute one of the most important branches of scientific work any government is called upon to undertake. That such work should in all cases be under the control of the General Government, and that general governments should co-operate with each other in establishing uniformity of standards, is a fact usually admitted as beyond dispute. Until recent years this work has been confined to problems concerned with the standards of length, mass, capacity and temperature; but the increased order of accuracy demanded in scientific and commercial measurements and the exceedingly rapid progress of pure and applied science have increased the scope of such work until it includes many important branches of physical and chemical research, requiring for its successful performance a complete laboratory, fitted for undertaking the most refined measurements known to modern science.

Germany has established the Physikalische-Technische Reichsanstalt and the Normal-Aichungs-Commission; England, the Standards Department, the Electrical Standardizing Laboratory, and the National Physical Laboratory (but recently established); Austria, the Normal-Aichungs-Commission; and Russia, the Central Chamber of Weights and Measures. These, together with the institutions of other countries and the International Bureau des Poids et Mesures, at St. Cloud, France, are organized for the purpose mentioned and are noted for the very important work they accomplish annually. An examination of the function of these institutions and the sums of money devoted to their maintenance is the most convincing evidence of the importance of problems pertaining to standards and standard-measuring apparatus.

Throughout our country institutions of learning, laboratories, observatories and scientific societies are being established and are growing at a rate never equaled in the history of any nation. The work of original investigation and instruction done by these institutions requires accurate reliable standards, which in nearly every case must be procured from abroad, or can not be procured at all.

The extension of scientific research into the realm of the extremes of length, mass, time, temperature, pressure and other physical quantities necessitates standards of far greater range than can be obtained at present. Frequently the comparison of the same physical quantities vary with the magnitude of the quantity to be measured, and may even introduce entirely new conditions, methods and apparatus, as in the case of high or low temperatures.

The introduction of accurate scientific methods into manufacturing and commercial processes involves the use of a great variety of standards of far greater accuracy than formerly required. An accurate knowledge of the high temperature of a furnace or refinery, or the low temperature of a refrigerating process, is often essential to the economical working of the process.

Enormous commercial transactions are daily based upon the reading of electrical measuring apparatus, inaccuracies of which involve great injustice and financial losses; hence the national bureau should be in a position to calibrate or test electrical standards of all kinds for commercial, as well as the most refined scientific work.

The scientific work carried on by the different departments of the Government involves the use of many standards and instruments of precision, which are too frequently procured from abroad, owing to our own lack of facilities for standardizing.

The manufacture of scientific apparatus and instruments of precision has been confined almost exclusively to foreign countries, but at present is growing at a rate which will soon place our own production on a par with that of any other country. In order to secure the requisite degree of uniformity and accuracy it is absolutely essential that American manufacturers of such apparatus have access to a standardizing bureau equivalent to that provided for the manufacturers of other countries, notably Germany and England.

The recent acquisition of territory by the United States more than proportionately increases the scope and importance of the proposed institution, since the establishment of a government in these possessions involves the system of weights and measures to be employed. During the near future large public improvements will be undertaken in these countries; schools, factories, and other institutions will be established, all of which require the use of standards and standard measuring apparatus.

Ample facilities should be provided for the investigation of problems which arise in connection with standards and standard measuring apparatus, since it is by the solution of these problems that the standardizing department is enabled to meet the demands of modern and improved methods of measurement.

The work of the Office of Standard Weights and Measures has been of a high order, and as extensive as the appropriation, working force, and quarters would permit; but in view of its great importance to scientific and commercial interests, it is earnestly requested that its functions be enlarged to meet the requirements of existing conditions, and that it be provided with a suitable laboratory, equipment and working force.

NATIONAL ACADEMY OF SCIENCES,
Washington, D. C., April 19, 1900.

SIR: In response to your request and by authority of the National Academy of Sciences I have the honor to communicate the following resolution, adopted by the Academy at its present session:

"Whereas the facilities at the disposal of the Government and of the scientific men of the country for the standardization of apparatus used in scientific research and in the arts are now either absent or entirely inadequate, so that it becomes necessary in most instances to send such apparatus abroad for comparison: Therefore, be it

"*Resolved*, That the National Academy of Sciences approves the movement now on foot for the establishment of a national bureau for the standardization of scientific apparatus."

I am, sir, yours, with great respect,

WOLCOTT GIBBS,
President.

THE SECRETARY OF THE TREASURY,
Washington, D. C.

STATISTICS RELATING TO STANDARDIZING INSTITUTIONS OF FOREIGN GOVERNMENTS.

England.

Standards Department.—Established in 1879, to provide for the custody of the standards; to construct and verify copies of the standards; to verify standards in use by local authorities; to regulate the system of inspection in use in the Empire. Under board of trade. Work directed by a superintendent of weights and measures.

Total annual expenses, including salaries, equipment, and incidental expenses for the year 1897–98. .... $15,700

Electrical Standarizing Laboratory.—Established 1890, for general electrical testing and the verification of electrical standards and measuring apparatus. Situated at Old Palace Yard, Westminster. Under board of trade. Work directed by a chief electrician.

Total annual expenses, including salaries, equipment, and incidental expense for the year 1897–98.. $8,600

Kew Observatory.—Established 1871, at Old Deer Park, Richmond, Surrey. Originally founded as an astronomical observatory; then as a meteorological observatory; now as a general testing bureau. Under Royal Society of London. Affairs controlled by the Kew Observatory committee. Work directed by a superintendent. Recently incorporated in the National Physical Laboratory.

Total annual expenses, including salaries, equipments, and incidental expense for the year 1897–98 (almost wholly derived from fees)...................... .... $17,800

National Physical Laboratory.—Established 1899, to be situated at Old Deer Park, Richmond, Surrey. To be a general standardizing laboratory where standards and measuring instruments in use in science or in trade may be verified. Research work may be undertaken when required for the needs of the laboratory or regarded as of distinct value to the public generally. To this institution will be added the buildings, grounds, equipment, and income of the Kew Observatory, thus placing the latter institution under the general head of government institutions. Work to be controlled by a committee of leading scientists, and under immediate control of a director.

Annual appropriation, 1900–1901, for salaries, equipment, and incidental expenses (above the income of Kew Observatory)............... $20,000

Germany.

Die Normal Aichungs Commission.—Established 1868, at Berlin, to regulate the system of inspection of weights and measures throughout the North German Confederation; to construct and provide standards and the necessary measuring apparatus for the local bureaus; to fix regulations in regard to the system of inspection, and to provide for the safe custody of the standards. Under the immediate supervision of a director, aided by the commission, which is composed of scientific men who have been connected directly or indirectly with matters pertaining to weights and measures. Two hundred and fifty thousand dollars was appropriated in 1899 for new buildings and equipment.

Total annual expenses, including salaries, equipment, and incidental expenses for the year 1897–98.. $36,000

Die Physikalische-Technische Reichsanstalt.—Established 1887, at Charlottenburg, as a national physical laboratory and standardizing bureau. Under the control of a president, with an advisory board or council of scientific men. The total appropriations to date for buildings, grounds, and equipment amount to over $1,000,000.

Total annual expenses, including salaries, equipment, and incidental expenses for the year 1897–98.. $80,000

The Reichsanstalt is organized in two sections, as follows:

Section I.—The execution of physical investigations and measurements which aim at the solution of scientific problems of great importance, which require a greater outlay of time, equipment, and materials than are at the disposal of institutions founded primarily for educational purposes. The work of the section also includes the solution of such scientific problems as may arise in connection with the work of Section II.

Section II.—(1) The execution of physical or technical investigations, as required by the Government, or which are of such a character as to further the interests of German manufacturers of instruments of precision, and other branches of technological work, such as the determination of the physical properties of materials, the preparation of materials, the best methods of construction for technical and measuring apparatus.

(2) The verification and calibration of measuring instruments and standards of reference not provided for by the Aichungs Commission.

(3) The construction of instruments, or parts of instruments, and the execution of the mechanical work needed in connection with the equipment and investigations of the institution, and for other bureaus of the Government, so far as such work cannot be afforded by private workshops.

(4) The execution, in special cases, of work similar to that mentioned in (3) for German manufactures.

The Reichsanstalt is reimbursed for work performed in accordance with (3) and (4) upon the basis of the cost of material and double the time employed.

Austria.

Normal Aichungs Commission.—Established at Vienna in 1871, upon the adoption of the metric system by Austria; to exercise a technical control over the inspection of weights and measures throughout the Empire; to establish regulations regarding inspection; to fix the limits of tolerance; to provide for the custody of the standards; to construct and verify copies of the standards; and to equip the local inspection bureaus with copies of standards and measuring apparatus; to verify, for institutions and individuals, standards and measuring apparatus submitted. The commission is subordinate to the Minister of Commerce, and is composed of a director and a number of co-ordinate members. The director is empowered to appoint a suitable force of technical clerical assistants.

Total annual expenses, including salaries, equipment, and incidental expenses for the year 1897–98.................................... $46,000

Russia.

Central Chamber of Weights and Measures.—Established 1878, at St. Petersburg, reorganized 1893, to exercise control over all systems of weights and measures in use in the Empire. The work at present is largely preliminary, and comparisons are confined to standards of length, mass, and capacity, but it is the intention of the Government to include the comparison of thermometers, barometers, hydrometers, alcoholometers, etc., and electrical measuring apparatus. Experiments in most of these branches are now being conducted in the laboratories of the chamber, and results of extreme precision are now being obtained, under the minister of finance and the supervision of a director. One hundred and seventy-five thousand dollars was originally appropriated for buildings and grounds.

Total annual expenses, including salaries, equipment, and incidental expenses, for the year 1897–98.................................... $17,500

The total amounts annually appropriated by different governments for standardizing purposes are as follows:

Germany	$116,000
England	62,100
Austria	46,000
Russia	17,500
United States	10,400

A NEW ENZYME OF GENERAL OCCURRENCE IN ORGANISMS.

A PRELIMINARY NOTE.

WHILE occupied with investigations on the enzymes in the tobacco leaf the writer observed that the clear filtered juice of the fresh leaf, although giving strong reaction for oxidase and peroxidase, yields but a very weak reaction with hydrogen peroxid, *i. e.*, develops mere traces of oxygen upon addition of this substance. The *unfiltered* juice, however, containing in suspension protein matter, chlorophyll bodies, starch granules, etc., yields a very energetic development of oxygen. This behavior caused the writer to doubt the correctness of the now generally adopted teaching that the power of catalyzing hydrogen peroxid is a property of all enzymes. The known enzymes are soluble in water and although they can be retained in a certain measure by some suspended matters, the difference of behavior of the unfiltered and filtered juice in the case just mentioned could hardly be so very marked.

Further tests have shown the writer that the power of catalyzing hydrogen peroxid is found also in manufactured tobacco which had been air-cured, while flue- or fire-cured tobacco was generally indifferent in this regard. Air-cured tobacco that was subjected to a subsequent 'sweating in bulk' shows this power often in a high degree although it is impossible to find the common enzymes. Even oxidase and peroxidase may be destroyed in the sweating process, without the loss of this catalytic power.

Further tests have revealed the fact that various enzyme preparations of commerce, as emulsin, papain, trypsin, may have no trace of the power of catalyzing hydrogen peroxid and nevertheless be very powerful in their specific actions, and it is evidently only due to another substance of enzyme nature present as an impurity when the common enzymes exhibit that catalytic power on hydrogen peroxid. This specific substance occurs in an insoluble and in a soluble form. The former seems to be a compound of the latter, a kind of albumose, with a nucleo-proteid. There seems to exist no plant and no animal which is without that peculiar enzyme, which the writer proposes to name *catalase* from its catalytic action on hydrogen peroxide. It belongs to the group of the oxidizing enzymes.*

In aqueous solution this enzyme is 'killed' between 72° and 75° C. Its action on hydrogen peroxide is retarded by certain salts, especially nitrates of the alkaline metals, and stimulated by others, as sodium carbonate.

One of the functions of this enzyme appears to be to prevent any accumulation of hydrogen peroxid which might be formed as a by-product in the series of energetic oxidations that characterize the cellular respiration process. Hydrogen peroxid is a poison for the living protoplasm, hence the activity of catalase is of vital importance. Recent investigations of Eugen Bamberger and also of Manchot leave no doubt that hydrogen peroxid is generally produced in the process of autoxidations of many labile organic compounds when exposed to air.

A detailed investigation of catalase will be published in a special Bulletin of the U. S. Department of Agriculture.

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*It also plays a rôle in the 'sweating' process of tobacco.

THE RECENT ANNUAL RECEPTION AND EXHIBITION OF THE NEW YORK ACADEMY OF SCIENCES.

The seventh annual reception of the New York Academy of Sciences took place April 25th and 26th, at the American Museum of Natural History. A beautiful and spacious hall on the main floor in the east wing was assigned by the Museum authorities and proved admirably adapted for the purpose. The several branches of science were in charge of the following specialists, who together made up the general committee:

Anthropology, Franz Boas.
Astronomy, J. K. Rees.
Botany, D. T. MacDougal.
Chemistry, C. E. Pellew.
Electricity, Geo. F. Sever.
Geology and Geography, R. E. Dodge.
Metallurgy, H. M. Howe.
Mineralogy, L. McI. Luquer.
Paleontology, Gilbert van Ingen.
Physics and Photography, Wm. Hallock.
Psychology, Edw. L. Thorndike.
Zoology, Charles L. Bristol.

In the section of Anthropology, some of the interesting collections of the Jesup and Huntington expeditions to the northwest coast were shown. They illustrated designs in gold from the Amoor river; the archæology of the coast of southern British Columbia, including jade implements from graves, that were very striking; and implements of the Eskimo of Southampton Island. In addition, symbolism among the Arapahos received attention, and basketry work from California was well represented. In the section of Astronomy the work of many observatories was exhibited through the courtesy of their Directors. The Lick observatory showed photographs of nebulæ; the Lowell observatory at Flagstaff, Arizona, its recent work on planets and satellites; the University of Pennsylvania, its results with the zenith telescope; Sir Norman Lockyer, his enlargement of the spectrum of Alpha Cygni, and the Columbia University observatory various lines of recent work.

The Botanical section contained many individual exhibits and others which specially illustrated recent progress at the New York Botanical Garden. Many preparations were shown with microscopes. Professor Geo. E. Stone, of the Massachusetts Agricultural College, had one series of apparatus that he had used in the study of plant physiology, and that attracted especial attention. Under Chemistry the new synthetic indigo and numerous artificial perfumes drew the attention of many visitors, while recently developed apparatus and preparations interested others. At the tables devoted to Electricity many new and improved forms of apparatus were shown. In the section of Geology and Geography, the U. S. Geological Survey gave a very full exhibition of its recent maps and publications, all of which aroused much interest and many inquiries. The work of the Maryland Geological Survey and Weather Service was admirably presented and received very favorable comment.

Metallurgy appeared this year for the first time, and was especially rich in illustrations of Metallography, as developed in the School of Mines at Columbia University. New varieties of steel; various metals, more or less rare; alloys; by-products and refractory materials gave many visitors an opportunity to see objects seldom exhibited. Under Mineralogy, the greater number of the new minerals described during the year were shown, and many superb specimens of older ones. Of especial interest was a series of 51 specimens of American tellurides, shown by Professor A. H. Chester, of Rutgers. The Egleston Museum of Columbia University displayed both minerals and apparatus. In Paleontology, the most interesting exhibits were the recent collections of vertebrates from the West by the parties of the American Museum. The remarkable find of five complete skeletons of the last extinct horse of North America (*Equus occidentalis*), which was previously known only in scattered individual bones, excited the liveliest interest. In addition, a camel that possessed many features of the giraffe, and complete mounted skeletons of *Oxyaena* and *Patriofelis*, together with many other fine specimens, gave visitors an idea of the remarkable progress of the Museum in this branch. The members of the Academy were gratified to note that Mr. Charles Knight is continuing his restorations, two new ones being shown, viz, *Tylosaurus* and *Megaceros hibernicus*. A valuable collection of fossil fish recently acquired by the American Museum, from Ohio, was also shown through the courtesy of Professor Whitfield.

Under physics and photography, Dr. P. H. Dudley exhibited further results of his observations upon strains in rails under moving trains by means of the 'stremmatograph,' his valuable and ingenious instrument, invented for this purpose. The great advantage of heavy and stiff rail sections was clearly proved. Photographs in color by means of diffraction gratings, and kinetoscope projections of the motion of a wave, both by Professor R. W. Wood of the University of Wisconsin, excited great interest. In addition many other forms of ingenious apparatus received careful attention from visitors. In the section of psychology the chief exhibits consisted of new forms of apparatus. One, by Professor Cattell, projected simultaneously upon a screen, by means of the lantern, a time scale, a curve of breathing and another of pulsation, both while being produced by a person, engaged in any prescribed occupation. This received especial attention from visitors.

On the tables devoted to zoology the visitor saw a beautiful series of photographs illustrating progress at the new Zoological Garden of New York, and few, not familiar with the facts, were prepared for the results displayed. Many preparations of an anatomical nature were exhibited by others, and many of an embryological character, oftentimes under the microscope, attracted deep interest. A series of beautifully mounted heads of venomous and non-venomous snakes, by R. L. Ditmars, gave an excellent idea of their differences in dentition and structure.

On the whole, the exhibition maintained the high standard established in former years and gave instruction and pleasure to between two and three thousand members and their friends. Every possible courtesy was extended by the officers of the American Museum, and the Academy is again placed under a debt of gratitude to them. Our thanks may also be expressed in this place to the many friends whose contributions made the exhibition a success, and of whom only a small part could be specially mentioned above.

J. F. Kemp,
Chairman of Committee.

SCIENTIFIC BOOKS.

The International Geography. By Seventy Authors; edited by Hugh Robert Mill, D.Sc. New York, D. Appleton & Company. 1900. Pp. 1088, with 488 illustrations.

The International Geography is a large, single volume compendium of geography, rightly named international, both from the standpoint of scope, and from that of authorship. The seventy authors who have co-operated in the enterprise have been chosen from all parts of the world, each to write on his own specialty, so that the editor has secured the most eminent help possible in each of the chapters of the book. We find, for instance, that Sir John Murray contributes a chapter, with the Editor, on the ocean; Professor Penck, a chapter on the Austro-Hungarian Monarchy; and Mr. H. O. Forbes, a chapter on the Malay Archipelago, all of which are but random illustrations, that are typical of the work as a whole.

The volume is divided into two parts, the first, of 122 pages, devoted to the Principles of Geography, and the second, of 930 pages, to Continents and Countries. In the second part, each of the continents is considered in detail by countries, and special chapters are devoted to the Polar Regions. The volume closes with an accurate, inclusive, and very satisfactory index, covering 35 pages.

One reviewer has stated that perhaps no one but the editor was personally qualified to review adequately such an inclusive and complete summary of the present geographical conditions of the world, a remark with which many of us will perhaps agree. No complete analysis is, therefore, contemplated here; but attention will be given to certain special features of the volume, first, as to its general usefulness, and second, as to the special chapters on the United States and North America.

The present reviewer feels that the volume under consideration ought to be of every day use to nearly every advanced teacher of geography in grammar schools, and to every trainer of future geography teachers in normal schools and colleges, and has introduced the volume with satisfactory results in one large class of school teachers studying geography. In this volume teachers and all others who have need of getting quickly in touch with the best in reference to all countries, find that best, told concisely, interestingly, clearly and effectively. Supplied with a good atlas and this volume, any teacher is well equipped as to opportunity for securing the best information for daily use. One of the particularly valuable features of the book is that it is adapted to the abilities of the audience to which it would appeal. The editor and the authors are to be congratulated in that they did not miss their mark.

The special chapters dealing with America were written by Professor W. M. Davis, and Mr. J. B. Tyrrell, formerly of the Canadian Geological Survey; Professor Davis writing on North America as a whole, and Mr. Tyrrell on the Dominion of Canada. In the chapter on North America, Professor Davis starts out with certain comparisons between North and South America, and between North America and Eurasia. Following this is a consideration of the Coast Lines; the Laurentian Highlands; Glacial Action; the Appalachians; Rocky Mountain System; the Great Plains; Climate; Rainfall and Vegetation; Aboriginal People; and History. The plan followed in reference to the United States is characterized by the editor as novel, and 'perhaps the most instructive in the book.' Surely it is not too much to say that in the sixty-three pages devoted to the United States we have the best existing summary of the present geographical features of our Republic, causally considered. In the regional description of the United States the area is divided into physical provinces, and in each the effect of the physical features in shaping or determining the social and economic conditions in the present or past is well brought out, and so skillfully done that the political phase seems a necessary part of the physical phase, as is, perhaps, best shown in the section on New England.

The chapter is accompanied by an outline map of the United States, which is particularly graphic and usable. It will be noted from the map that the author's division of the United States into physical divisions differs very materially from the divisions previously published by our workers in geomorphology. The scheme here used is simple and accurate, and equally well suited to those who know the several regions personally, and to those who do not. This chapter should be read by all who desire a clear, interesting, and faithful account of the United States.

As a whole, the volume deserves a place among the necessary reference books, at ready call in all libraries, public and private. There are few inaccuracies and few typographical errors; the book being printed in a pleasing and attractive manner on paper that, though thin, is good, so that the volume is not unwieldy in spite of its length. This volume will, undoubtedly, be the standard one volume reference book for years to come, and the editor deserves great praise for his skill and care in carrying to successful completion a complicated and difficult enterprise.

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A Manual of Psychology. By G. F. STOUT, M.A., LL.D. London, University Correspondence College Press. 1899. Pp. 643.

The psychological world has been anticipating this book with lively interest since the appearance of the author's *Analytic Psychology* in 1896. In the preface to that work Dr. Stout writes as follows: "When I first planned the present work, it was my intention to follow the genetic order of treatment. But I found myself baffled in the attempt to do this without a preparatory analysis of the developed consciousness. * * * I therefore found myself driven to pave the way for genetic treatment by a previous analytic investigation; and the result was the present work. It must, therefore, be regarded, even in respect to my own plan of procedure, as a fragment of a larger whole. * * * I may say that my strongest psychological interest lies in certain genetic questions, and especially in those on which ethnographic evidence can be brought to bear." In judging the *Manual*, then, one must keep in mind its predecessor which is, in a certain sense, also its complement. It is, however, necessary to observe, at the same time, the distinct offices of the two works. The first is a general, systematic treatise; "its aim is to bring systematic order into the crowd of facts concerning our mental life revealed by analysis of ordinary experience:" the second is a text-book. Many divergences in the two which one is inclined, at first sight, to lay to a change in standpoint are undoubtedly to be ascribed rather to a difference in the manner of exposition.

There is no doubt that the wave of psychological enthusiasm which has been advancing so steadily for a quarter of a century is tending to eddy into a series of specific, but profound interests. The change is natural; it might have been read beforehand from the history of any one of the older disciplines. Systematic thinking reorganizes itself by concentrating at critical points, as really as does matter by the redistribution of its functions. Just now one of the currents of psychological thought is flooding towards the genetic center of activity. Is it not time, many psychologists are asking, to construct a paleontology of consciousness upon the basis of collected fragments? Can we not read out of the successive strata of mind the distinctive features of an eopsychic, a mesopsychic, and a cenopsychic period? The best answer to these questions at present (and the best is poor) is given in the few comprehensive attempts really to write genetic psychology. I say 'few' because so much of the mass of what is called genetic work has been built upon a generous and sympathetic interest in brutes and infants instead of upon firm psychological principles, and has simply washed away.

These are some of the circumstances which make the present volume so sincerely welcome at the door of psychology. It comes from a pen which has already traced its way through the intricacies of the problems of the developed human consciousness under the lead of the whole English school of psychological thought.

What the author understands by the genetic method is clearly stated in the preface to the 'Analytic' volumes. Stout says: "What is called the genetic or synthetic method, instead of attempting merely to ascertain and define the processes of the developed consciousness as we now find them, proposes to itself the task of tracing the evolution of mind from its lowest to its highest planes." Let us see how the program has been carried out in the *Manual.*

The general arrangement of the book is very much like that of the *Analytic Psychology.* Each has a number of introductory sections on the scope and methods of psychology, followed by a 'general analysis,' and this, in turn, by a discussion of mental processes. But here the similarity ceases. The earlier work deals largely with matters of methodology and of psychological theory; filling out what Kant would call the architectonic of the science; while the *Manual* deals directly with its subject-matter. Since it is more concrete and less formal, the genetic volume approaches much nearer the actual mind of experience. After the ground has been cleared, three stages in the development of mind, the sensational, the perceptual, and the ideational, are treated in turn and furnish material for the main divisions of the work.

It is to be noticed at the outset that the mind with which the *Manual* deals is the knowing and doing mind. "Psychology," we read, "is the science of the processes whereby an individual becomes aware of a world of objects and adjusts his actions accordingly." And again, "psychology finds a certain world of objects presented, let us say, to an educated Englishman of the 19th century, and it inquires how this world has come to be presented. * * * The world of the young child, or the world of the Australian aborigine, are comparatively primitive formations; and the psychological problem is to discover how the transition has been made from these earlier stages to the later stages with which civilized adults are now familiar." The author, following Ward, makes the *presented object* the important datum for psychology: "except in the case of pure sensation," we read, "none of these processes (sensation, perception, attention, volition, etc.) can either exist or be conceived apart from a presented object." And, "the development of an individual mind is at the same time the development of the objective world as presented to that individual mind." That is, the problem of psychology as it appears to Stout is the *functioning* of mental processes: 'how does mind make its world?' rather than 'what processes at this or that level of development exist as processes in consciousness?' It is rather the efficiency of the machine than its construction that is investigated.

We may arrive at the same point from another direction. The author's 'ultimate modes of being conscious' are those which are marked out in the *Analytic Psychology.* They are the cognitive attitude, the feeling attitude, the conative attitude. These are all, notice, attitudes toward an object; they all depend upon the presentation of an object. Hence, the reference of consciousness beyond itself is kept constantly in the foreground.* Modes of being conscious resolve themselves into 'modes of being conscious of an object.'

For the cognitive experience the author retains Ward's 'presentation' using it, however,

*One exception is made: sensation is defined as conscious event (though it was said earlier that sensation could not be conceived apart from a presented object), but the author soon gets from this into cognition through the sensation reflex.

in a more limited sense (barring motor presentations). The feeling attitude implies that we are 'pleased or displeased, satisfied or dissatisfied with' an object. The term is broader than feeling-tone—which is a 'generic word for pleasure and pain'—since emotion involves unique and irreducible feeling attitudes. Finally, the peculiarity of the conative attitude is the "inherent tendency [in mental states] to pass beyond themselves and become something different. It is the teleological drift of consciousness; it has a positive phase, 'appetition' and a negative 'aversion.' Conation includes attention as a special case. "Attention is simply conation in so far as it finds satisfaction in the fuller presentation of its object, without actual change in the object." After discussing these ultimate modes, the 'primary laws of mental process' are given. These laws formulate the manner of going-along and going-together of processes. The chapter includes a group of apparently heterogeneous topics; relativity, conative unity and continuity, retentiveness, association, reproduction, acquirement of meaning, facilitation and arrest, habit and automatism, and physiological dispositions. The coherence of the chapter is in several places, doubtful. The most important point in the chapter, both from a genetic and an analytic point of view is, in the writer's opinion, the exposition of 'cumulative dispositions': the effect, that is, of an earlier upon a later consciousness without the reinstatement of the earlier experience. It is the problem that Spencer grappled with, by no means successfully, in his general law of association, and one which very much needs working out in detail.

The general analysis closes with a clear, concise statement and criticism of 'faculties' and 'associationism.' The opening of Book II. brings the student to the real subject matter of the science. This Book, which covers about the same number of pages as the preliminary chapters, is occupied with sensation. Sensation is, for the author, a 'special form of consciousness' produced by some condition outside the nervous system, *i. e.*, a stimulus. On account of differences in intensity, steadiness, etc., the 'sensory elements' in images are not included in sensation. Sensations are dealt with in psychology both as 'psychological states' and as 'vehicles of knowledge.'

It is to be noted that sensation is not always treated here as an abstraction; for it is maintained that 'mere sensation' exists concretely even in adult experience. This is an important point, because Stout's genetic scheme, as developed later, assumes that sensation is not necessarily something totally distinct from a cognized object or any bit of cognition, as experimental psychology insists, but a concrete kind of consciousness which forms the initial member in the genetic series.

The 'sensation reflex' (a self-contradictory term!) it is which emerges above the physiological reflex and becomes 'the most primitive form of mental life which is distinctly recognizable.' The physiological reflex passes into the sensation reflex (1) when a special emergency arises, as coughing, *e. g.*, and (2) when the mind is not too much pre-occupied by higher processes. A meagre enough *raison d'être* for consciousness? Apart from the difficulty of tacking consciousness on to a complete and efficient physiological mechanism, there is the question why a consciousness thus added should be the same in kind as an ultimate element of the developed consciousness, *i. e.*, sensation. Is it not more likely, as Ebbinghaus remarks (*Grundzüge der Psychologie*, Vol. I., p. 10) that the original consciousness was, like the derivative one, a complex, not a wholly simple one? Stout partly saves himself from confusing an analytic and a genetic simple by endowing the sensation reflex with both 'conative' and 'hedonic' attributes; it may include appetition or aversion, and pleasure or pain. But with these endowments does not the sensation reflex really become an *impulse*, and would not the type of consciousness be better described as impulsive than as 'purely sensational'? The author does, in fact, go so far as to call it incidentally a 'sensational impulse.' Surely, a better term, especially since he lays so much emphasis on the teleological aspect of consciousness.

With this chapter on the primitive consciousness is started the genetic plan. As experience develops raw sensation becomes less and less, meaning, significance becomes more and more;

the perceptual consciousness becomes relatively more prominent, while "sensation is more delicately differentiated, more definitely restricted, less intense, and less strongly toned in the way of pleasure or pain." At the same time—and this is very important for the author's functional standpoint—differentiation means a less immediate reaction and a more clever planning for remote ends. Beyond these general statements and a hint at the corresponding development of organs, the *Manual* is decidedly disappointing in its treatment of differentiation; a concept which Spencer handled so boldly, when there was a paucity of knowledge on the subject, and which James and Ward have since made promising, but have not worked out.

We pass rather suddenly from these general synthetic questions to a detailed study of the various senses. A chapter is given to vision, one to audition, one to 'Other Sensations,' one to the 'Weber-Fechner Law'—a summary of Meinong—and a final one to the 'Feeling-tone of Sensation.' We cannot stop to point out many things that are admirable both in selection and in arrangement, or to indicate possible lines of criticism. There is, on the whole, a general suggestion of perfunctoriness in this part of the work. The material used shows the traces of second handling; it is, however, for the most part from reliable sources (chiefly Ebbinghaus and Foster), and is brought down to date. We find occasional lapses in the strict use of sensation; for example, we read of the 'sensation of softness and smoothness,' 'position-sensations and movement-sensations' and, finally, sharpness and bluntness, hardness and softness, wetness and dryness are spoken of as 'peculiar qualities of sensation.' Surely a gross confusion of sensation and perception, which is defined as 'the cognitive function of sensation.' Another difficulty arises in connection with the feeling-tone of sensation. It was remarked earlier that feeling-tone, including pleasure and pain, is one of the feeling attitudes; but here we find a whole chapter under sensation devoted to feeling-tone. Now, if feeling-tone is an ultimate mode of being conscious, how can it be a feeling-tone of sensation, *i. e.*, a variable dependent upon sensation which is not an ultimate mode of consciousness?* If, in other words, feeling-tone is a feeling-attitude and demands relation to an object, how can it be the feeling-tone of sensation which abstracts from the object? Still, we are told that feeling-tone does exist on the level of 'mere sensation.' The confusion, in both cases, evidently arises from the failure to keep distinct the architecture of mind and the offices it fulfils as interagent between the organism and the objects which it knows. It is to be remarked that, in the sensation chapters, the genetic standpoint is almost entirely forsaken. This is somewhat surprising, since sensation was the datum from which the phylogeny of mind was started. It is, again, the sensation abstracted from the introspected consciousness at odds with its *alter ego*, the sensation of genesis. In view, then, of the confusion which necessarily pervades this section and of the obvious shift of standpoint, one is tempted to remark that the work would have gained rather than lost by the omission of most of the chapters on Sensation.

The third and fourth books, on Perception and Ideation, respectively, are much more satisfactory than the Sensation chapters. An admirable introductory chapter to the third book gives the characteristics of the perceptual consciousness. Perception is the cognitive function of sensation, but it has also a conative aspect and a feeling-tone; it is not only reference to an object, but it is an active striving toward, and striving implies feeling. The Perception chapters breathe the spirit of that wholesome conservatism which has recently been infused into genetic psychology. It is clear that the author has a program worked out, and worked out on the basis of facts rather than from logical formulæ. Two things are insisted upon: first, the categories of the developed consciousness must not be thrust upon the primitive mind, and, secondly, the activity of the organism must be reckoned with in mental development; the individual is not to be regarded as an inert mass that draws in the world by a kind of mental attraction: he learns by doing

* We may even go deeper than this and ask how the genetic series can be started, at all, with something which is not an ultimate mode.

—whatever 'doing' may mean in psychological terms.

Imitation receives scanty notice. Emotion is more adequately treated; still, one is surprised to find the genesis of emotive states so little dwelt upon. The opportunity for giving a valuable account of the history of emotion has not been seized. The last part of Book III. is devoted to special percepts and includes Perception of External Reality, of Space, and of Time.

The ordinary distinction is observed between perception and idea; perception is based on sensation, as we have seen; it is the meaning which sensation acquires, while idea is similarly related to image. "The image is no more identical with the idea than sensation is identical with perception. The image is only one constituent of the idea; the other and more important constituent is the meaning which the image conveys." Our old difficulty arises here. Image is surely itself a 'meaning term.' Even as Stout has defined it, it differs from perception in lacking the external stimulus; it does not depart from perception in wanting meaning, but, as he puts it, in being worked out 'in the head.' It is, then, a representation, a 'mental picture.' As he himself illustrates it: "If I think about the Duke of Wellington, the image present to my consciousness may be only the shadowy outline of an aquiline nose." Think of the outline of an aquiline nose being conscious 'stuff,' devoid of meaning! It is two degrees removed; it is not only not a bit of consciousness, it is not an image; although one may have an image of it. The same confusion appears when the author turns to examine the characteristics of the 'mental image,' and asks: "In what respect does an object as merely imaged differ from the same object as actually perceived?" Not a psychological question at all, as it is put. To make the matter quite explicit we read a little farther on: "In what follows the object as perceived is simply called the 'percept' and the object as imaged, the 'image.'" Having gone so far, we are not surprised to come upon a serious discussion of Hume's 'force and liveliness' as 'distinctive of sensations.' Now it is one thing to compare sensations, peripherally and centrally aroused, with each other, and quite another to compare the 'percept' with the 'image.' Clearly, Hume's task was the latter. It must be said that the author enters into a more serious and painstaking investigation of idea and image than is commonly to be found in general treatises. His introspection is full and fresh, but not always free from ambiguity. In the following instances he does not seem to be quite sure-footed: "What the stimulus does for us in perception, we have to do for ourselves in ideation." "Images are maintained before consciousness purely by an effort of attention." "Ideas follow each other in accordance with purely psychological conditions." "In merely imaging 'the attention feels as if drawn backward towards the brain.'"

Under the heading 'Trains of Ideas' comes the discussion of Association and of Ideal Construction. The substance of the chapter is that associations are due to 'continuity of interest,' and the associated material is modified to suit the associating consciousness. There is little to note in the memory chapter. Memory is reproduction; some suggestions are offered towards raising its efficiency. In the treatment of comparison, conception and language we get back to the genetic problem, and, at the same time, come upon a delightfully clear and carefully thought out exposition of one of the cruces of psychology: the passage from the idea to the cognitive processes which stand upon the next higher level. After the stage of conceptual thinking is reached by the aid of language, whose function it is to break up the concrete items of sense perception and re-combine them into new wholes, the author proceeds to elaborate the process by which the external world and the self are produced as ideal constructions. The first motives to such construction are found to be practical: the bringing coherence and order into experience and the adjustment of the individual to his fellows in the community.

With Royce and Baldwin, Dr. Stout gives the social factor peculiar importance in this process. Involved with these constructions is the matter of belief and the distinction between belief and imagination. With Bain, the author finds the key to belief to lie in its relation to activity. Here again the influence of society is emphasized.

The feeling attitude is considered not only on the levels of sensation and of perception, but also now in connection with ideas. Ideational activity itself is said to possess feeling-tone; this is connected with the furtherance and obstruction of conation; furtherance, the working out of the activity, giving pleasure and its opposite, pain. It is to be noted that the three references to feeling, upon the three developmental planes, involve some ambiguity in the use of terms. Pleasure and pain, and pleasantness and unpleasantness are often confused. It would have aided the student if different terms had been used to denote simple affection, the feelings of the perceptual stage, and the more involved hedonic aspects of discursive thinking. As an example, pain is often used where simple unpleasantness is evidently meant; as in the checking of a 'conative activity.' The distinction between pain and 'pain-sensation' is also confusing.

Finally, in the last chapter, the reader comes within sight of what he has been looking for all the way through; some systematic explanation of conation and of conative development. The reviewer is inclined to think that, without a previous analysis of conation, and also of impulse and of attention, many steps in the author's argument would be incomplete. Perhaps the full treatment in the *Analytic Psychology* is sufficient. Still, considering the difference in the two audiences which the author reaches, it is, perhaps not demanding too much to ask for a more complete analysis of these terms which are used constantly throughout the book.

The author acknowledges a very great debt to Dr. Ward, and the influence of the master is prominent all through the work. Naturally, Professor James' general point of view is also approached; although in matters of special interpretation Stout dissents from his opinion more often than he accepts it. While the book is predominantly British in its mode of treatment, it comes nearer a compromise between English and German psychologies than does any book which we have yet had from a writer of the English school, excepting, perhaps, Professor Sully's psychology. When one considers the product in connection with the soil to which it is indigenous, one can but note the marked effects of fertilization from imported systems. Although the *Manual* will scarcely fulfil at present a textual function in the class-rooms of our colleges and universities, American psychologists will know it and will find it stimulating and helpful.

Finally, to revert to the query with which we set out, we shall have to say that the genetic standpoint is not maintained with the rigor which we were led to expect from the author's preliminary definition of it; but that where it has been adhered to, it is used with profound psychological wisdom and a keen insight into the dark vistas of mental development.

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CORNELL UNIVERSITY.

Matières odorantes artificielles. GEORGES-F. JAUBERT. Docteur ès Sciences, ancien Préparateur de Chimie á l'Ècole Polytechnique. Petit in-8. Pages 190. (Encyclopédie scientifique des Aide-Mémoire.)

The title of this book is both misleading and vague. It is misleading because it does not cover the indicated field, but only discusses three classes of odorous substances, the remaining classes being reserved for the author's forthcoming volumes on 'Les Produits Aromatiques' and 'Les Parfums Comestibles,' the subject thus being distributed through the three volumes. Further, it is vague, in that it is not, as might be expected, a bird's-eye view of synthetic perfumes, for at least one-third of its space is taken up with compounds which have no interest whatever as perfumes, and which apparently are inserted, either from their chemical relationship to other substances in the tables, or because, although possessed of no valuable odor themselves, they happen to occur associated with some natural perfumes in certain essential oils. The reviewer is of the opinion that the author might better have confined himself to a tabulation of those synthetic organic compounds whose odor renders them of commercial value, or which are of scientific interest from their being identical with certain natural aromas.

The author proposes the terms 'odorophore' and 'odorogen,' to be used in a manner analogous to the 'chromophore' and 'chromogen' of the color chemists. Thus, he considers the phenolic OH as an odorophore, which becomes an odorogen when its H is replaced by an alkyl or acyl group; in support of which he cites the following examples:

$HOC.C_6H_4.OH$(paraoxybenzaldehyde) = little odor.

$HOC.C_6H_4.OCH_3$(anisic aldehyde) = odor.

$HOC.C_6H_3<^{OH}_{OH}$ (protocatechuic aldehyde) = little odor.

$HOC.C_6H_3<^{OCH_3}_{OH}$(vanillin) = odor.

$HOC.C_6H_3<^{O}_{O}>CH_2$ (piperonal) = odor.

The work is divided into the following chapters:

I. Halogen and Nitro Compounds.—Includes the halogen derivatives of phenylethane, and of styrol; mirbane and Musc Baur.

II. Aldehydes, Dialdehydes and Oxyaldehydes.—Among the more important aldehydes listed are those of benzoic, phenylacetic, cuminic, cinnamic, salicylic, anisic and piperonylic acids. Vanillin, however, is reserved for the author's volume on 'Les Parfums Comestibles.'

III. Phenols and Phenolic Ethers.—Among others the following are discussed: thymol, carvacrol, anisol, diphenyl ether, anethol, betanaphthyl ethers, eugenol and safrol.

Each chapter begins with a few pages of explanatory text, followed by a tabular classification of the compounds belonging to that particular group. The column headings, for the tables are as follows: trade name; scientific name; formula, empiric and constitutional; method of preparation; literature and patents; properties and characteristic reactions. The references to the literature and patents are particularly valuable.

Although the compounds are well arranged in a logical chemical classification, an Index would nevertheless be a desirable addition.

MARSTON TAYLOR BOGERT.

BOOKS RECEIVED.

Elements de paléobotanique. R. ZEILLER. Paris, G. Carré and C. Naud, 1900. Pp. 421.

A Treatise on Zoology, edited by E. RAY LANKESTER. Part III.: Echinoderma, F. A. BATHER, J. W. GREGORY, E. S. GOODRICH. London, Adams and Charles Black, 1900. Pp. vi + 344.

First Book, Home Geography and the Earth as a Whole. RALPH S. TARR, FRANK M. MCMURRY. New York and London, The Macmillan Company, 1900. Pp. xv + 279.

Prantl's Lehrbuch der Botanik. FERDINAND PAX. Leipzig, Wilhelm Engelmann, 1900. Pp. viii + 455.

Reinhardt's Technic of Mechanical Drafting. CHARLES W. REINHARDT. New York, The Engineering News Co., 1900. Pp. 36. 10 Plates.

SOCIETIES AND ACADEMIES.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis, on the evening of April 2, the following subjects were presented:

A paper by Dr. H. von Schrenk, entitled 'A Severe Sleet-storm,' and embodying the results of a study of the injury to trees and shrubs by an unusually severe recent sleet-storm, was presented by title.

Dr. W. H. Warren read a paper giving an outline of recent progress in the chemistry of perfumes. For the most part, these substances are high boiling oils. Formerly these oils, which are complex mixtures of several compounds, were obtained exclusively from flowers, but recently some of the essential principles have been produced by chemical means, whereas other artificial perfumes are mere imitations. With a few exceptions the essential principles, which give the perfumes their value, belong to a complex class of organic compounds known as the terpenes. The terpenes are reduction products of cymol. The molecule is characterized by the presence of an atomic linking such as is found in the hydrocarbon ethylene, and the determination of the exact location of these ethylene linkings constitutes a difficulty in studying the terpenes. It is found also that nearly every substance having the properties of a perfume has in its molecule certain atomic groups whose presence exerts a marked influence on the odor. Among the more important of these may be mentioned the aldehyde, ketone, ester, ether and alcohol group. Besides those terpenes which have the ring-structure in the molecule, there are substances which have long chains of carbon atoms. Apparently such compounds should be classified with fatty compounds, but so closely do they resemble the terpenes in their properties and chemical behavior that they are placed with them instead. Citral or geranial, an aldehyde found in largest quantity in oil of lemon-grass, is such a substance. Citral is of importance because it is the starting-point in the synthesis of ionone, the artificial violet perfume. The wonderful progress in our knowledge of the terpenes and of their derivatives is the work of scarcely more than ten or fifteen years at the most. There is great activity still, and among those chemists who have taken a prominent part in the labor should be mentioned Wallach, Baeyer and Tiemann.

Six persons were elected active members of the Academy.

William Trelease,
Recording Secretary.

THE TORREY BOTANICAL CLUB.

At the meeting of Torrey Botanical Club on March 13, 1900, a paper was read by Dr. P. A. Rydberg, on the 'Phytogeography of Montana.' He divided Montana into three regions, the Great Plains, constituting about one-half of the State, and the sub-Alpine and the Alpine regions, the last constituting those isolated peaks which exceed 9000 feet. The characteristic plant-coverings of each region, termed formations, were classed under the usual groups as Xerophytic, Mesophytic, Hydrophytic, and Halophytic, which were fully discussed.

Dr. Rydberg's paper was followed by remarks by Judge Brown on the beauty of the mountain flora, and by Dr. Britton on the Dodge expedition of 1897, of which the paper is a result. Dr. Rydberg said in answer to Dr. Underwood that the Montana flora extends but little westward of the State. Dr. Underwood referred to the interest attaching to any possible influence of hot springs upon the flowering-time of plants growing near, and called attention to the very early flowering of *Ranunculus Cymbalaria* along ditches supplied with hot water baths near Syracuse, New York.

Edward S. Burgess,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 322d meeting was held on Saturday, April 21st. L. O. Howard exhibited, with explanatory remarks, 'Some New Illustrations of Insects,' comprising series illustrating the different genera of mosquitoes, the species of flies presumably connected with the carriage of germs of diseases of the intestinal tract, and of fig caprification in California.

F. W. True spoke of 'The Newfoundland Whale Fishery,' his remarks being illustrated by lantern slides. The fishery for finback whales carried on at Snook's Arm, Notre Dame Bay was described in some detail, the speaker stating that a small, swift steamer was employed which cruised in the adjacent waters where the whales were taken by means of a harpoon gun. After being killed the whales were towed to the harbor and by the use of a steam winch hauled out upon an inclined plane where the blubber was rapidly removed.

F. A. Lucas.

DISCUSSION AND CORRESPONDENCE.

THE OFFICIAL SPELLING OF PORTO RICO.

To the Editor of Science:—Some time since there appeared in your paper a contribution from a distinguished Washington geographer to the effect that President McKinley had issued an order that the name of the island of Porto Rico should be spelled 'Puerto' Rico. There likewise appeared in the *National Geographic Magazine* for December, 1899, an anonymous personal communication stating in effect that I was the only government official who adhered to the form Puerto Rico.

I beg to inform you that in an Act of Congress passed April 11th and signed by the President of the United States, April 12, 1900, 'to provide revenues and a civil government for Porto Rico,' the word Puerto was stricken out wherever it occurred and *Porto* substituted therefore. The President's signature to this bill and the statutory act of Congress settles the spelling of the name of the island. Puerto

Rico is now a thing of the past, and like all unpronounceable foreign words has sacrificed its life to the dictum of the law of the least effort. It was never used by the American or English people and may now be laid upon the shelf with Nuevo Mejico, Nouvelle Orleans and others of their kind.

In determining this form of the word the Congress has followed the undoubted usage of the English language for 300 years and scotched an effort to fix upon our people and language a name and a principle which were never accepted by them.

ROB'T T. HILL.

LINGUISTIC FAMILIES IN MEXICO.

TO THE EDITOR OF SCIENCE:—In the *American Anthropologist* (N. S., II., 63–65), I have brought Pimentel's list of linguistic families in Mexico into harmony with the scheme of the Bureau of American Ethnology. It occurs to me that it will post the ethnology of the Republic up to date to add the names of families not mentioned by Pimentel, and to spell them in accordance with Major Powell's scheme for North America. Then families, language names, and tribal names will not be confounded. For example, the *Mayas* or *Maya* people, speak the *Maya* language, of the *Mayan* family. The *Mangues*, speak the *Mangué* language, belonging to the *Chiapanecan* family.

PIMENTEL'S LIST.	LIST PROPOSED.
Apache.	Athapascan
Chontal (Oaxaca.)	Zapotecan or Tequistlatecan
Guaicura y Cochimi-Laimon	Yuman
Huave	Huavan
Malalzingao Pirinda	Otomian
Maya-Quiché	Mayan
Mexicana	Nahuatlan*
Mixteca-Zapoteca	Zapotecan
Otomies	Otomian
Seri	Serian
Sonorense Ópata-Pima	Piman, or Nahuatlan
Tarasca	Tarascan
Totonaca	Totonacan
Zoque-Mixé	Zoquean.

NOT IN PIMENTEL'S LIST.

Chiapanecan, in Chiapas.
Chinantecan in Oaxaca.
Keresan or Kerean, in Chihuahua.
Tequistlatecan, Triquis and Chontals in Oaxaca.
Guaicura and Matlalzinga may prove to be families.

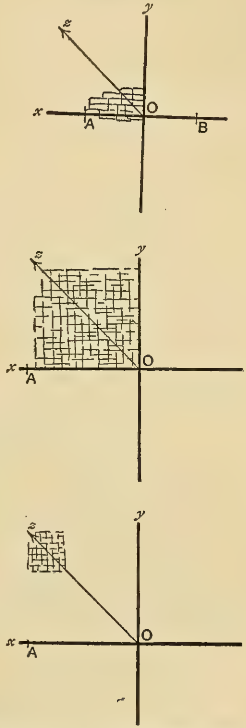
O. T. MASON.

* Professor Payne in History of America constantly uses Nahuatlacan.

HEMIANOPSIA IN MIGRAINE.

THE visual symptoms frequently occurring in migraine ('sick-headache,' so-called) have been described (see *e. g.*, Wood's *Reference Hand-book of the Medical Science, sub verbo*) by

FIGS. 1, 2, 3.



Optical symptom in migraine (Figs. 1–2). *O*, point of fixation in center of left hand held laterally 18 in. before the eyes. *AB*, length of hand. *OZ*, direction of development of symptom (hemianopsia in left upper quadrant). Fig. 1. Initial stage, true size (about), only symptom of any sort present. Fig. 2. Maximum stage, accompanied by massive headache, and beginning of nausea. Fig. 3. Final stage (before rapid fading), violent, more localized headache and nausea. (In Figs. 2 and 3, *AO*, equals *AB* of Fig. 1.) Duration of symptom 1 to $1\frac{1}{2}$ hour. Symptom is invariably for recurrent attacks, and for monocular (either eye) and binocular vision; and has a fluttering wavy movement which cannot be figured.

medical authorities; but I know of no attempt to figure the appearance in the field of vision. Subjoined I give figures showing my own visual modification in three stages—initial, maximum and final—with the location and local progress of the symptom, taken during an attack last summer, after freedom from the headaches for years. It was brought on probably by the glittering effect of the sun on the water in sea-bathing, an inducing cause sometimes noticed by other observers, and rather frequent in the period of boyhood and youth in my own case.

The area covered by the peculiar net-work shown in the figures is bright light-gray and the configuration itself is of the appearance of water-bubbles or divisions. The lines are all straight and at right-angles to one another. The progress of the stigmate, if that term be allowed, is interesting from the point of view of theories of the localization of the trouble in the brain. The initial appearance covered the left half of the hand held eighteen inches before the face; it gradually spread leftward and upward (never downward or rightward) until it covered the whole hand when the gaze was fixed a little to the right of the hand and on the line of its lower edge. It then travelled off the hand by contracting upward and leftward (as shown in Fig. 3). This would indicate that the disturbance began in the right half of the visual area (occipital lobe) of the right hemisphere, or in the corresponding subcortical centers or tracts, spread over the entire upper half of that area (left upper quadrant of the field of visions), then died away progressively in the same order, this inference depending, of course, on the hypothesis of a projection of the elements of the visual area upon the retina.

It is interesting from the psychological point of view to note that a strong and persistent effort to call up the appearance, as for drawing a figure of it or describing it, produces in my case positive sensations of nausea.

J. MARK BALDWIN.

OXFORD, January 20, 1900.

THE DEVELOPMENT OF PHOTOGRAPHIC PLATES IN THE LIGHT.

IT may be of interest to your readers to know that if photographic plates in a camera are greatly over-exposed they may be developed in the light. A plate which should for ordinary work have an exposure of a second and a half for street or outdoor photography may be exposed for two hours. When developed with a weak hydrokinone by the light of a lamp, it gives a beautiful positive. The lamp is preferable because one can manage the degree of illumination. If the plate is held too near the lamp it will dissolve a picture already appearing. If held too far away the plate begins to fog. By moving toward or from the lamp the proper illumination may be soon secured. It is remarkable that a street scene taken in this way shows not a moving thing on the streets. Street cars passing every two minutes, wagons, horses, pedestrians, all have apparently vanished without leaving a trace upon the plate. But the fixed objects are shown perfectly, with their proper shadows and high lights.

In this way lantern slides and transparencies may be made directly without re-photographing from a negative.

FRANCIS E. NIPHER.

THE TOPOGRAPHIC SURVEY OF OHIO.

THE Ohio Legislature has just passed its appropriation bill for the year 1901. It contains an item of $25,000 for the inauguration of a topographic survey of the State, in co-operation with the United States Geological Survey. This insures the systematic beginning of the field work next year, and the friends of the measure are confident that it will be continued until the entire State is covered.

The initiative in the movement for securing co-operation was taken by the Ohio State Academy of Sciences at its annual meeting in December, 1896, since which time a committee of this body has been active in promoting the measure. At the legislative session of 1898 a bill passed the Senate and was in good favor in the House, largely through the earnest support given it by State Senator James R. Garfield. But the outbreak of the Spanish war necessitated a large appropriation for possible military expenditures, and so it was cut off. All parties gave the measure increased support in the campaign just closed. The scientific societies of the State, including the civil engineers and the mining engineers, the college men, the wheelmen, the chambers of commerce and the principal newspapers all co-operated in securing the gratifying result already mentioned.

Ohio offers many interesting problems in topographic history, reaching as it does from the deeply-trenched, unglaciated southeastern portion, with its great systems of reversed drainage, to the flat lake plain of the north, with its beaches, moraines and buried channels. In due time this area will be added to that of the States to the eastward, where similar systems of co-operative survey are giving, or have already given, their topographic structure to the world in accurate and worthy maps.

ALBERT A. WRIGHT.

THE ARCHÆOLOGICAL REPORT OF ONTARIO.

THE usual Ontario Archæological Report by David Boyle has appeared for 1899. It is printed by Warwick Bros. and Rutter, Toronto, 1900, as part of the appendix to the report of the Minister of Education. Upwards of two thousand specimens have been added to the museum of the Education Department, Toronto. A number of pipes and other specimens are figured. Of special interest are a description and figures of two perforated skulls found in Simcoe County, Ontario. The perforations are considered to be post-mortem, or at least to have been made immediately before the individual's death. The skulls are considered to be of Huron Indians, and remind one of the similarly perforated skulls described by Dr. Henry Gillman. Mr. E. H. Crane, of Niles, Michigan, has a skull from the Saginaw Valley which is also perforated in this manner.

An 'Iroquois Medicine Man's' mask is figured and described, and a brief report is given of the exploration of mounds examined by Mr. Boyle on Pelee Island in Lake Erie. Mr. G. E. Laidlaw contributes a paper on new sites in Victoria County; Mr. Andrew F. Hunter, on sites of Huron villages in the township of Tay, Simcoe County, with some bibliographic references; Mr. W. J. Winternberg, on Indian village sites in the counties of Oxford and Waterloo. 'The Wyandots,' by William E. Connelly; The War of the Iroquois,' by M. B. Sulte; 'Notes on Some Mexican Relics,' by Mrs. Wm. Stewart; 'Music of the Pagan Iroquois,' with music by Mr. A. T. Cringan; and 'A Study of the Word Toronto,' by General John S. Clark—are also included in the report.

Mr. Boyle has patiently worked for years to create interest in the archæology of his province. These labors are at last being supplemented by assistance from other students in the same region. Until the subject is more studied, it is well that his efforts to preserve the records and specimens be encouraged.

HARLAN I. SMITH.

EXPERIMENT STATION EXHIBIT AT THE PARIS EXPOSITION.

AT the meeting of the Association of American Agricultural Colleges and Experiment Stations, held at Minneapolis in 1897, a resolution was adopted in favor of a co-operative experiment station exhibit at the Paris Exposition. A committee, consisting of H. P. Armsby, chairman; W. H. Jordan, A. W. Harris, M. A. Scovell, and A. C. True, was appointed to take charge of the matter. The stations were invited to contribute materials and charts illustrating special features of their work and results, original pieces of apparatus, models, designs, etc. The material as it was prepared was shipped to Washington. Dr. True, Director of the Office of Experiment Stations, undertook to make a collection of photographs and publications of the stations, to prepare a monograph on the experiment station enterprise of this country, and to look after the temporary installation of the exhibit in Washington and its final shipment.

The photographic exhibit includes about 750 selected pictures of station buildings, grounds, laboratories, apparatus, experimental plants, herds and other features, in addition to a collection of photographs of the station directors and staff members. The pictures are mounted in groups on sheets of heavy cardboard, 22 by 28 inches, and will be displayed in portfolios of twenty-four each.

A series of root cages, furnished by the North Dakota Station, shows the formation of the roots of maize, wheat, flax and brome grass; models of sweet potatoes, peppers, apples and plums exhibited by the Iowa and Minnesota stations illustrate varietal differences; and an exhibit of saltbush from the California Station shows species of *Atriplex*, which have proved of value on strongly alkaline soils. Electrical devices for determining the salt content, temperature and moisture content, and a series of samples illustrating the typical agricultural soils of the United States, represent the soil work of the Division of Soils of the U. S. Department of Agriculture. The California Station sent six typical soils of that State, and specimens showing the results of mechanical analyses of each type of soil, and Hilgard's soil elutriator for mechanical analysis.

The California Station furnished an olive exhibit, consisting of fifty samples of olive oils and more than two hundred samples of olive pits used in the classification of varieties of olives; and the Alabama Station, a collection of mounted specimens of cotton, showing seventy-two selected and crossbred varieties.

Several pieces of original apparatus for investigations in vegetable physiology are shown, including an auxanometer for experimental work on the rate of plant growth; an apparatus for determining the rate of transportation of plants, from the West Virginia Station; and a centrifuge, used to study the effect of gravity and centrifugal force upon germinating seeds, from the Indiana Station.

Samples of animal and vegetable fats, a collection of chemically pure proteids separated from the seeds of various plants, a collection of one hundred weed seeds, an insect cabinet, a gas desiccator for drying hydrogen gas used in moisture determination, models of round and stave silos, an apparatus for the rapid cooling of wines, a pressure apparatus for experiments with solution under very high pressure, a model of the Atwater-Rosa respiration calorimeter and a full-sized bomb calorimeter are included in the exhibit.

The dairy exhibit is larger than that in any other line. It includes a series of cheese models from the New York State Station, showing the effect of the fat content of the milk on the size of cheese produced; a collection of forty-eight cultures of dairy bacteria, from the Connecticut Storrs Station; the original Babcock milk tester, two more modern forms of the apparatus for hand and power operation, together with a complete collection of the various forms of apparatus used in the Babcock test. The Scovell milk-sampling tube, Wisconsin curd test, Marshall rennet test, acid bottles and other minor apparatus are also included.

The irrigation exhibit of apparatus and models contains a hydrophore to determine the amount of silt carried by water; a nilometer used to measure the amount of water passing through streams, flumes and ditches; a current meter, water register, etc.

A small exhibit from the Hawaiian Experiment Station consists of samples of rocks, lavas, lava products, soils, varieties of sugar cane and samples of agricultural products, such as coffee, rice and sugar.

There is a large number of charts and enlarged pictures showing the results of experiment station work on a wide range of subjects, a complete set of bound bulletins and reports numbering several hundred volumes, and many miscellaneous publications of the stations, together with over one hundred books on agricultural subjects written by station officers.

The arrangement and shipment of the exhibit was in charge of Dr. W. H. Evans, of the Office of Experiment Stations, who also supervervised the preparation of the charts and photographs exhibit.

Especial interest attaches to this exhibit from the fact that it shows the great progress made by our stations since the Paris Exposition of 1889, when the stations made only a small showing, as they were just beginning active operations under the Hatch Act.

SCIENTIFIC NOTES AND NEWS.

DR. A. A. MICHELSON, professor of physics at the University of Chicago, has been elected a corresponding member of the Paris Academy of Sciences.

DR. C. HART MERRIAM has been elected a foreign member and Mr. Samuel Scudder a corresponding member of the Zoological Society of London.

THE philosophical faculty of the University of Göttingen has given the prize of the Wohlbrecht's foundation for works on natural science of the value of 12,000 Marks to Professor Gegenbaur the eminent Heidelberg zoologist.

PROFESSOR J. K. REES, of the Department of Astronomy of Columbia University, has been appointed an international juror in the department of the Paris Exposition, which is in charge of instruments of precision.

THE Government of India has decided to assign Captain Robert M. Elliot to the special duty of investigating on the nature and action of snake venom.

THE University of Edinburgh on April 14th, conferred its LL.D. on Dr. A. Stuart, professor of physiology in the University of Sydney; on W. R. Sorley, professor of philosophy in Aberdeen University, on Dr. C. D. F. Phillips, the pharmacologist, and on Miss Eleanor Ormerod, known for her contributions to entomology. On conferring this degree, Professor Grant remarked that it was the first time that the degree had been conferred by the University on a woman.

THE University of Glasgow, on April 17th, conferred the degree of LL.D. on Mr. A. Smith Woodward, of the Geological Department of the British Museum, and on Mr. Robert Caird, president of the Scottish Institution of Engineers and Shipbuilders.

IN honor of the twenty-fifth anniversary of Dr. Daniel Coit Gilman's election as President of the Johns Hopkins University, his colleagues in the faculty have presented to the University a three-quarter life-size oil portrait. It has been hung in McCoy Hall.

A BUST of the late Professor Egleston and a bronze tablet will be given to Columbia University by students of the School of Applied Science.

THE death is announced of M. Planchon, since 1886 director of the Paris School of Pharmacy at the age of sixty-seven years. He was a brother of the celebrated botanist Émile Planchon.

SIR WILLIAM PRIESTLEY, a well-known London physician and member of parliament, a grand-nephew of the discoverer of oxygen, died in London on April 11th at the age of eighty-one years.

RODNEY G. KIMBALL, since 1869 professor of applied mathematics in the Brooklyn Polytechnic Institute, died on April 25th.

THE death is announced of Mrs. Lankester known for her writings on botany and other scientific subjects, her best known work being the text of Sowerby's British botany.

THE death is also announced of M. Philippe Salmon, assistant director of the School of Anthropology, Paris, also president of the commission of megalithic monuments and member of the commission on historic monuments.

THE Senate has passed the agricultural appropriation bill, which carries $4,120,000, retaining the item of $170,000 for the purchase of seeds for distribution.

THE bill creating a National Department of Commerce and Industry will probably not be considered for lack of time during the present session of Congress, but special efforts will be made on its behalf next year.

BY the will of Charles E. Smith, formerly president of the Philadelphia and Reading Railway company, the Philadelphia Academy of Natural Sciences receives one-sixth of an estate valued at nearly $500,000, as also a collection of botanical books and a herbarium. His books on technical science are left to the Franklin Institute.

THE preliminary arrangements have been completed for taking the official observations in Mexico of the total eclipse of the sun on May 28th. These observations will be made by the National Observatory, under direction of the Federal Government. The places selected are Montemorelos and Santa Helena, both near Monterey. The astronomers appointed to perform the work are Francisco Rodriguez Rey, Manuel Morenoy Landa, Manuel Pasirana, Fernandez de Lindro, Augustin Aradon and Pedro Sanchez. Miss Rose D. Fallorend, of California, secretary of the Astronomical Association of the Pacific Coast, will also take observations of the eclipse from Santa Helena.

HERR MENCKE, of Hanover, is undertaking in his yacht a scientific expedition to the German Islands in the South Seas. He will himself pay special attention to ethnology and will be accompanied by Dr. Heimroth, assistant in the Zoological Garden.

Nature states that Messrs. W. Goodfellow and C. Hamilton have lately returned from a successful expedition in the Colombian and Ecuadorian Andes, during which they made a collection of upwards of 5000 bird-skins, comprising examples of many rare species. The travellers landed at Buenaventura, on the Pacific Coast, in April, 1898, and thence crossed the Andes into the valley of the River Cauca. This was ascended, and, passing through Popayan, Messrs. Goodfellow and Hamilton entered the Republic of Ecuador, at Tulcan, proceeding thence to Quito, where a lengthened stay was made. From Quito excursions were effected to Pichincha, and to the low country on the Pacific Coast near Santo Domingo. Leaving Quito on March 1st, last year, Messrs. Goodfellow and Hamilton crossed the Andes to the upper waters of the Napo, and descended that river in canoes to Yquitos, in Peru, whence the journey home was effected by steamer. Mr. Goodfellow is preparing an account of the birds collected during this remarkable journey for the *Ibis*.

Professor John M. Macfarlane, of the University of Pennsylvania, has returned from an expedition to North Carolina, where he succeeded in obtaining a number of specimens.

Four zoological lectures have been arranged before the Zoological Society of London to be given on Thursday afternoon as follows:

April 19th—'The Animals of Australia,' Mr. A. Smith Woodward, F.Z.S.

May 17th—'The Freshwater Fishes of Africa,' Mr. G. A. Boulenger, F.R.S., F.Z.S.

June 21st—'The Gigantic Sloths of Patagonia,' Professor E. Ray Lankester, F.R.S., F.Z.S.

July 19th—'Whales,' Mr. F. E. Beddard, F.R.S., F.Z.S.

The following are among the lecture arrangements at the Royal Institution after Easter: Dr. Hugh Robert Mill, three lectures on studies in British geography; Dr. Alexander Hill, two lectures on brain tissue considered as the apparatus of thought; Professor Dewar, four lectures on a century of chemistry in the Royal Institution; Dr. Alfred Hillier, two lectures on South Africa, past and future. The Friday evening meetings will be resumed on April 27th, when a discourse will be given by the Right Hon. Lord Kelvin on 19th century clouds over the dynamical theory of heat and light; succeeding discourses will probably be given by Professor T. E. Thorpe, Mr. Sidney Lee, Professor J. A. Ewing, Mr. Francis Fox, Sir Henry Roscoe, and others.

The Springfield Zoological Club has arranged a series of lectures on some of the divisions of the animal kingdom, to be given in the Art Museum on Friday evenings. They will be given by Messrs. Chas. B. Wilson, F. F. Smith and Dr. Geo. Dimmock.

The position of assistant geologist in the U. S. Geological Survey, with a salary of from \$900–\$1200 per annum will be filled as the result of a civil service examination on May 22d and 23rd. The subjects and weights are:

(1) Essay on a geologic topic	10
(2) English composition (rated on subject one)	10
(3) Geology	40
(4) Drawing (rated on required work in subjects one and three)	5
(5) French and German	5
(6) Physics, chemistry, mineralogy and mathematics	10
(7) Education and experience	20
Total	100

Notice has been received at the Swedish and Norwegian consulate, in this city, that the King of Sweden and Norway has decided to reward persons who have found objects belonging to the Andrée Polar Expedition, and that a fund has been set aside for rewards for persons who may hereafter find objects from the expedition.

The 'Kaiserliche Gesundheitsamt' at Berlin, has established a biological section for the study of micro-organisms and other influences favorable or harmful to cultivated plants. The first publication from the section has recently been issued.

The annual general meeting of the Society of Chemical Industry will be held in London in July. Professor C. F. Chandler, of Columbia University, the president and a number of American chemists expect to be present.

THE first meeting of the International Conference for the Protection of Wild Animals in Africa was held at the British Foreign Office on the 24th of April. The British representatives were the Earl of Hopetoun, G.C.M.G., Sir Clement Hill, K.C.M.G., C.B., head of the African department of the Foreign Office, and Professor Ray Lankester, director of the Natural History Museum.

THE twenty-ninth annual congress of German surgeons convened at Berlin on April 18th, under the presidency of Professor von Bergmann.

THE Jacksonian prize of the Royal College of Surgeons of England has been awarded to Dr. H. S. Lack for an essay on the 'Nasal fossæ.' The subject for next year is 'Bullet wounds of the chest and abdomen.'

THE first volume of the *Annals of the South African Museum* is completed with the issue of part 3, its 456 pages making a substantial contribution to our knowledge of the natural history of South Africa. The first article, Chap. XI. of the present instalment on 'New and Little Known South African Solifugæ in the Collection of the South African Museum,' by W. F. Purcell, contains descriptions of ten new species of *Solpuga* and of five little known species of the genus; four new species of *Dæsia* and three of *Ceroma*, these genera being recorded from S. Africa for the first time; also a new *Hexisopus* and the first description of a male of this genus. Chap. XII., also by W. F. Purcell, is devoted to descriptions of 'New South African Scorpions in the Collection of the South African Museum,' and Chap. XIII. contains 'Descriptions of Twelve New Species of the Genus *Mutilla* (Order Hymenoptera) in the South African Museum' by L. Péringuey. The final paper, Chap. XIV. is 'On Two New Species of Dicynodonts,' by R. Broom. The title page and index for the volume are issued with this part.

THE Council of the Zoological Society has given instructions for the publication of an index-volume to the new generic names mentioned in the *Zoological Record*, Vols. xvii.–xxxvii. (1880–1900). The volumes previous to Vol. xvii. have been indexed in the 'Nomenclator Zoologicus' of Scudder, published by the Smithsonian Institution in 1882. The contemplated index-volume of the *Zoological Record*, in order to increase its usefulness, will include names omitted from Scudder's list and from the volumes of the *Zoological Record*. Thus zoologists may have at their disposal (in the 'Nomenclator Zoologicus' and the new index together) a complete list of all the names of genera and subgenera used in zoology up to the end of 1900. It is requested that anyone who knows of names omitted from Scudder's 'Nomenclator,' or from the volumes of the *Zoological Record*, will forward a note of them, together, if possible, with a reference as to where they have been noticed or proposed, so that the new list may be made practically complete. Such information should be addressed to the editor of the *Zoological Record*, 3 Hanover Square, London, W.; or to C. O. Waterhouse, Esq., British Museum, Natural History, S. Kensington, London, who is engaged in compiling the list.

UNIVERSITY AND EDUCATIONAL NEWS.

GENERAL THOMAS H. HUBBARD has given $150,000 to Bowdoin College to be used for a new library building.

PRINCETON UNIVERSITY and Lafayette College each receive about $45,000 by the will of Joseph Eastburn Smaltz.

MR. MICHAEL CUDAHY, of Chicago, has subscribed $50,000 toward the million dollars which Archbishop Keene is trying to collect for the Catholic University of America at Washington.

MISS ELIZA T. BRYSON, a generous benefactor of Teachers College, Columbia University, has bequeathed to the College $2500 for a scholarship.

VANDERBILT UNIVERSITY will celebrate with special ceremonies, in October next, the twenty-fifth anniversary of its opening.

THE University of the State of New York will hold its annual convocation on June 25th, 26th and 27th. Among the subjects to be discussed are manual training and libraries. It is expected that Mr. Hamilton Mabie will deliver the address on Tuesday evening. Dr. Nicholas Murray Butler of Columbia University, will present the report on the organization and plans of the joint college entrance board for the Middle States and Maryland. This report will be discussed in 10-minute speeches by President J. M. Taylor of Vassar, Dean Albert Leonard of Syracuse University, Dean Edward R. Shaw of New York University, and others.

At the April meeting of the Regents of the University of Nebraska, Dr. E. Benjamin Andrews, for some time Superintendent of Schools in Chicago, and formerly President of Brown University, was elected Chancellor of the University. His acceptance has been received, and he will assume his new duties August 1st, until which time Dr. Charles E. Bessey will be the acting chancellor. Dr. Charles A. Ellwood was elected instructor in sociology. An order was passed authorizing the Faculty to grant certificates to students who complete the courses of study in the schools of agriculture, mechanic arts, domestic science, and physical education, these being but two or three years in length, and not leading to a degree. The Faculty of the College of Literature, Science and the Arts recommended the adoption of more flexible conditions of admission to the Freshman Class, of which English (4 points), Language (6 points, 4 at least in Latin), algebra (2 points), geometry (3 points), and history (2 points) are specifically required, while the remaining eleven points are to be made up of combinations selected under certain restrictions, from Greek, Latin, German, French, history, physical science, natural science, advanced algebra, plane trigonometry, physiology, physiography, civics, and political economy. This recommendation was adopted by the Regents. The Faculty of the Industrial College made a similar recommendation, the specifically required points being English (4 points), Language (4 points, French, German, Latin or Greek, not more than two), algebra (3 points), geometry (3 points), physical science (2 points, chemistry *and* physics), natural science (1 point, botany *or* zoology). The remaining eleven points are to be made up of combinations, selected under certain restrictions, from French, German, Latin, Greek, manual training, history, physical science, natural science, plane trigonometry, mechanical drawing, physiology, physiography, civics, and political economy. This recommendation was adopted by the Regents. By action of the Regents the experiment will be made of having the college work almost entirely elective in the College of Literature, Science and the Arts, while in the Industrial College it will be (as now) very largely prescribed both as to subjects and sequence. The recommendations of the Faculty of the Graduate School in regard to admission to graduate work, and candidacy for advanced degrees, were adopted. But two degrees are offered, viz, Master of Arts, and Doctor of Philosophy, the first requiring at least one year of resident work, and the second not less than three years of work 'under properly qualified teachers,' the last year being in this University.

A department of marine engineering has been inaugurated at New York University, with Professor C. C. Thomas at its head.

The Adam T. Bruce fellowship in biology of the Johns Hopkins University has been conferred upon Lawrence Edmonds Griffin, Ph.B. (Hamline University). Mr. Griffin will go to Jamaica during the summer to pursue special research work.

Miss Margaret F. Washburn, Ph.D., professor of philosophy in Wells College, has been appointed Warden of Sage College, Cornell University.

Mr. B. Moore, M.A., professor of physiology at the Medical School of Yale University, and lately assistant professor of physiology at University College, has been appointed lecturer on physiology at the Charing Cross Hospital Medical School.

Dr. Eckstein has been appointed professor of zoology in the School of Foresty at Eberswalde. Professor Ramaun, professor of agricultural chemistry at Eberswalde, has been called to the University of Munich.

Dr. Bergt, of the Dresden Polytechnic Institute, has been appointed assistant professor of mineralogy at the University of Greifswald.

SCIENCE

Friday, May 11, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

REPORT OF THE WATSON TRUSTEES ON THE AWARD OF THE WATSON MEDAL TO DAVID GILL.

At the last annual meeting of the National Academy of Sciences the Watson medal was, on recommendation of the Trustees, awarded to Dr. David Gill, Her Majesty's Astronomer at the Cape of Good Hope, for his work in perfecting the application of the heliometer to astronomical measurements resulting in an important advance in astronomy of precision especially in the determination of the parallaxes of the sun and stars, and of the positions of the planets. In accordance with our custom I now have the honor to submit a fuller report on the work in question.

It is as true of the astronomer as of the poet that he must be born, not made. Although there is no branch of research in which a wider knowledge of the whole field of physical science and a broader grasp of first principles are necessary than in astronomy, it is none the less true that this knowledge and grasp must be supplemented by that indefinable quality born in the man which leads him to pursue astronomy with zeal and success. The career of our medalist offers a remarkable example of this fact. So far as can be inferred from his writings, his early training was rather in the direction of mathematical science, especially horology, than in that of astronomy. His first appearance as an active worker in the latter science was in connection with the transit of Venus in 1874. He was at that time the coadjutor of Lord Lindsay, afterward Earl of Crawford and Balcarres, who was so much interested in astronomy that he had erected an observatory at his seat, Dunecht, near Aberdeen. Gill was placed in charge of the institution and the works done there were published in the joint names of the two.

When the transit of Venus of 1874 was approaching, a special private expedition for its observation was fitted out by Lindsay, with Gill as his leading assistant. Here the latter gave the first evidence of that tireless energy which has marked his whole career. Not satisfied with merely executing the work pertaining to the expedition, he organized, under Lindsay's direction, a campaign to determine a chain of telegraphic longitudes from Berlin to Malta, Alexandria, Suez and Aden. From here the chain extended to Bombay, in the east, and to the Seychelles, Reunion, Mauritius and Rodriguez in the south. Thus the expedition, in addition to the observations which were its main objects, made an important contribution to geodesy and geography.

It was in connection with the observations of the transit that he made his first application of the heliometer, an instrument which he has since done so much toward bringing to its present state of perfection. Although this instrument had been in use in Germany for nearly half a century, and was celebrated as that with which Bessel had first determined the parallax of a star, astronomers were not alive to its possibilities. Its application was greatly restricted by the imperfection of its construction and, although one had long been mounted at Oxford, little use was made of it in England. In fact its application was limited by a defect of its construction. The Repsolds of Hamburg introduced the important improvement of making the two divided halves of its object glass slide in a circle having its center at the focus, instead of moving in plain guides, as in the former construction. Its range was thus greatly widened and its accuracy increased.

With the instruments as thus improved Gill, in addition to the observations which were the main object of the expedition, made at Mauritius his first essay in the line which he has since followed with such success; the determination of the solar parallax by observations of the minor planets. The planet chosen for the purpose was Juno. The method was that of observations as far as possible to the east and west of the meridian, the parallatic effect being obtained by the motion of the observer as he was carried around by the earth's rotation, instead of by differences of direction from two distant stations. The result of the observations was 8″.77, which we now believe to be a nearer approach to the truth than was supposed at that time.

The success of this attempt led our medallist to inaugurate another on a larger scale in which he was himself the sole actor and mover. This was his celebrated expedition to the Island of Ascension in 1877, in order to determine the solar parallax by observations of Mars at its perihelion approach to the earth, which occurred in September of that year. The method was the same as at Mauritius, the instrument used being the heliometer, and the parallatic effect being obtained by the difference in the direction of the planet in the morning and in the evening. The result of the work was worked out with that thoroughness which is characteristic of the highest order of astronomical research. One of its most important features was a discussion of the personal error in the right ascension of faint stars depending on their magnitude, an error which had long been suspected, but had evaded all efforts to so determine it that it could be eliminated from the results. It is now well established that, in our traditional method of determining right ascensions by transits of stars over the threads of a meridian instrument, all observers, whatever method they adopt, note the transit of a faint star too late relatively to a bright one. The error varies with the observer and the conditions to such an extent that its amount almost defies exact determination. The problem of getting rid of it is among the most serious with which the astronomer has now to contend.

One circumstance will illustrate the extreme precision reached by Gill in this work. The final discussion of his observations brought out a seeming periodic change in the longitude of Mars, going through its period in about half a month. Theory afforded no explanation of such a change. Years afterwards it was traced to an error in the ephemeris of the planet, which had been prepared for him by an official authority, in which certain extremely minute terms of the nutation were not consistently applied. So minute an error would never have been detected by any other method of observation.

The result found for the solar parallax was 8″.78. The main source of doubt to which it is subject, apart from unavoidable accidental errors, arises from the possible uncertainty in bringing the image of a star into coincidence with the center of a planetary disc. The effect of phase and a possible difference of personal equation in estimating the center of the planet on the two sides of the meridian introduce a certain amount of doubt. At the same time there is some reason to believe that the value is as near the truth as any that we can get at the present time.

One result of this expedition is of more than astronomical interest. It gave rise to a very pleasant book by Mrs. Gill, 'Six Months in Ascension,' describing life on a far distant island within the tropics, as well as the work of the expedition.

In 1881 Gill was appointed Director of the Observatory at the Cape of Good Hope, succeeding Mr. E. J. Stone. Although under the capable direction of the latter this establishment had continued to add to its reputation as one of the few important observatories in the southern hemisphere, no one could have seen in it an inviting field for astronomical research generally. Its instruments were antiquated, its means in other respects extremely limited, and its staff insufficient to the execution of any important enterprise. The general impression might therefore have been that, while an astronomer of ability might be able to do some good work at the Cape Observatory on traditional lines, it would be impossible for him to enter upon a great career. But the new astronomer soon showed that his energies were not limited by his unfavorable surroundings. He had learned what could be done with the heliometer, and what further improvements could be made in it in order to bring it to the highest state of perfection. Then he found an inviting field for its application.

The question of the parallax of the fixed stars has long been, from a scientific point of view, one of the most important with which the astronomer has to deal. To determine this quantity is equivalent to determining the distances of the stars and hence making a step towards estimating the dimensions of the universe and the arrangement of its constituent bodies in space. Twenty years ago the parallaxes of a number of fixed stars had been measured, but, in the greater number of cases the difficulty of the problem was such that the results were open to more or less doubt. The new and perfected heliometer was the best instrument for deciding the question and, by using it in the southern hemisphere, it was applied to a field almost entirely uncultivated. It is gratifying to us to know that, in this work, he found an able colleague in our fellow member, W. L. Elkin, who spent some time at the Cape Observatory, carrying on with Gill the work of the new instrument. It was one of the happy results of this co-operation that the Yale University was equipped with the finest heliometer that had then been made, and the instrument placed in the hands of Gill's co-worker. This is the only instrument of the kind that has yet been mounted on this side of the Atlantic.

The result of Gill's enterprise is that, at the present time, the parallaxes of perhaps a dozen stars of the southern celestial hemisphere have been determined with greater general precision than has been attained in the case of any corresponding number in the northern hemisphere. One conclusion from this work is of a nature to excite universal interest. The second brightest star in the heavens, Canopus, almost as bright as Sirius, has no measurable parallax. What must be the actual size and brilliancy of a star, which appearing to us as bright as Canopus is yet so enormously distant as to defy the most refined methods of determining its annual parallax? We can only answer with confidence that it is thousands of times the brightness of the sun. Whether we should say 20,000, 10,000 or 5000, no one can decide. What adds to the singularity of the result is that this case is by no means unique. Rigel and Spica, both of the first magnitude, are also beyond our range of measurement even with the most refined of instruments.

One prominent feature of the astronomy of our time is the initiation of international co-operative enterprises to carry on such of its researches as require to be conducted on a large scale. One of these enterprises was organized by our medallist. His experience in determining the solar parallax from observations of Mars and Juno led him to point out the advantages offered by near approaches of the minor planets generally to the earth for the determination in question.

In the course of a little more than a year, from the summer of 1889 to the autumn of the year following, there were to be three favorable approaches of these planets to the earth. An arrangement was made with the observatories of the world which had good heliometers in use, and were willing to engage in the work, to make the required observations. The labor involved in carrying out the whole plan in the best way was very great. The mere making of the observations was a simple matter compared with the subsequent reductions and investigations. The first step in the process was a determination, made with all possible precision, of the positions of the stars of comparison. Not only observers who used the heliometer, but all others who were willing to engage in the work took part in this branch of it. Then it was necessary to derive the best possible elements of motion of the three planets. The question how to discuss the observations so as to obtain results which should be as free as possible from the necessary errors in the elements was another important consideration.

The entire work appeared in 1897–98 as Vols. VI. and VII. of the Annals of the Cape Observatory. An examination of these magnificent volumes will give a better conception than anything that I can say of the amount of research devoted by Gill to this investigation. It is impossible within the limits of the present report to give even an abstract of their contents. We must therefore limit our notice to the general statement already made. It should, however, be mentioned in this connection that the discussion of the observations of one of the planets, Iris, was especially taken in charge by the collaborator whom I have already mentioned, Dr. Elkin.

The definitive results for the solar parallax from the three planets separately were:

From Victoria:	8″. 801 ± 0″.006	
" Sappho:	8″. 798 ± 0″.011	
" Iris:	8″. 812 ± 0″.009	

the combined result from the three, stated in round numbers, is 8″.00. This value has since been adopted, I believe, in all the astronomical ephemerides. That it will stand the test of time is however too much to expect. The improvements now being made in the means and the methods of research will necessarily include the solar parallax in their scope. But no change that may thus be made in the accepted value will diminish our admiration of the skill, industry and perseverance which our medallist has spent upon his greatest work.

While the investigations which I have mentioned, especially the last, are those which the academy had in view in awarding its highest honor in the field of astronomy, there is a work of another class of the first order of importance which cannot be passed over in silence. I refer to the 'Photographic Durchmusterung' of the southern heavens, from 18° of south declension to the pole. The third and completing volume of this work has just appeared. It offers several features of general interest. One is the curious fact that, with its completion, we now have a better knowledge of the stars of the southern heavens, invisible in out latitudes, than we have of the northern. It is an act of simple justice to one of our own countrymen now pursuing his work in the Argentine Republic, to say that this disparity in our knowledge of the stars in the two hemispheres is being markedly increased by the survey of the southern heavens carried on by Dr. Thome at the Argentine National Observatory. The fact that Dr. Thome employs the visual method instead of photography adds to its value in the present connection.

This enterprise of Gill's is intimately associated with the great international enterprise of making a photographic chart of the heavens. In 1882 a great comet appeared, and Gill engaged a Cape Photographer to take its picture. He was interested and surprised to find that along with the comet were taken the surrounding stars down to the 9th magnitude. Evidently here was a method of making star maps which offered great advantages over the laborious process of dotting down stars from eye observation. He communicated his suggestion to Admiral Mouchez, Director of the Paris Observatory and the question was taken up experimentally by the Henrys. The result was the Paris Photographic Conference of 1887, which inaugurated the enterprise now, we hope, approaching its completion.

An interesting circumstance may well command our attention. The Cape Photographic Durchmusterung is the work of two men, whose co-operation offers a remarkable example of that disinterested devotion to the increase of knowledge which is so conspicuous a mark of all modern science. The mere taking of the photographs was not the whole work, it was not even its main portion. The position of the stars on the glass plates must be carefully measured one by one, and every star-image studied by itself, with the view to determine its magnitude. How was it possible to devote the necessary attention to 350,000 separate objects? The one to do it was found outside of all English connections in the person of Professor J. C. Kapteyn, of the University of Groningen, Holland. I know not how many years of patient toil, which would have made the fortune of a business man, was spent by Kapteyn in this work. What gives interest to it is that it is an almost unique example in the history of science of a man of the highest order of general scientific ability in one country devoting his time to what was formally an official work of the government of a foreign country.

This attempt to set forth in a few words the scope and significance of twenty-five years unremitting labor on the part of one who would have made his mettle felt in any sphere of activity he might have chosen to enter may well appear to others, as it does to us, extremely inadequate. The work of Gill may fairly be called epoch-making in a sense even better than that in which the term is commonly used. If we find in it no brilliant discovery to attract the attention of the public, it offers us what is yet better; improved instruments and methods of research applied with such tireless industry, conscientious care, sound judgment, and accurate knowledge of every related subject as not only to expand our intellectual horizon, but to supply the astronomer of the coming generation a pattern which he can study with profit to himself and advantage to his science.

S. Newcomb.

EXPERIENCE NOTES UPON PLOT EXPERIMENTS.*

Field experiments are not easy to plan and very difficult in execution. Uncertainty attends every step from the soil to the seed —the cultivation to the harvesting of the crop.

During the past six years the writer has had two acres under experimentation, and no lesson has been more impressive than that of the lack of uniformity of the soil. An apparently even plot will vary in the composition and texture of the soil, almost from one foot to another. This may be due to many causes, not the least important being the rock strata, gravel beds, etc., that underlie the soil. The surface is usually far from level and the shaving down and filling in to bring the surface to a grade only emphasized the differences that already existed, as results upon the experiment grounds before mentioned abundantly prove.

The field itself should be laid off with exactness, and this means the aid of the surveyor or his instruments. The corner stakes should be set deeply and never removed, and those of each plot should be established once for all. Unless this is so the plots will move and the subdivisions will vary, and shortly the whole area is unsatisfactory, if not in confusion.

Ideal experiment grounds should have the same exposure. There are objections to perfectly flat land, and there are more to a rolling surface. The grounds under the charge of the writer are upon a slight incline, nearly uniform throughout the two acres; but even there a wash of the soil is always troublesome during heavy rains, and introduces an element of uncertainty when soil treatment obtains upon the plots.

There should be no tree, bush or other tall object upon or close to the trial grounds. The shade of a single tree may do more to disturb the course of an experiment with sun-loving crops than the sapping of the soil of plant food by the roots of the same tree.

This matter of the influence of shade has been tested by means of lath by the writer; it is very great, and incidentally it should play no part in the experiment grounds. It is not safe to grow corn or any like tall crop within many feet of any small crops, as lettuce or spinach. The scheme needs to be so planned that the question of shade is reduced to a minimum. This is one reason why the outside plants are not comparable with these in the interior of the plot.

A single back furrow or a dead furrow

* Presidential address before the Society for the Promotion of Agricultural Science, Columbus, Ohio, August 19th.

running through a plot will so change the capacity of the area as either to vitiate the results or render them exceedingly unsatisfactory. To avoid this and prevent the mixing of treated soil the writer has resorted to the spade.

He has experienced great difficulty in manuring the plots evenly. This is a practical difficulty, not appreciated by the average workman, and if the dung is drawn directly from the barnyard there may be a great variation according to the amount and character of the bedding used. The manure should be made by only one class of animals, as cattle or horses, or mixed with the greatest care. Instead of being spread upon the plots in winter it is better to place it in piles and when well rotted and forked add by weight or measure, preferably the latter, to the plots. With commercial fertilizers the above difficulty is eliminated.

During last winter a test was made of placing the piles of manure upon some of the plots for the purpose of determining the influence of the same upon the soil and crops. In every case the growth was much retarded and in some instances the seed did not produce more than a small fraction of the full quota of plants. The results of an experiment would have been worthless for any plot where a manure heap had been upon a portion of the ground.

It is not the purpose here to discuss the cause of the failure where the enriching was excessive, but the fact remains and any one who would follow plot experimentation must not fail to manure his land evenly with the greatest care and prohibit the piling of dung upon the plots.

Previous Crops.—One could have all the points in common save that of the previous crop and the results might be worthless. This the writer knows to his sorrow. The influence of a crop is more lasting than one might suppose. Of course the wide difference between sod ground and cultivated land goes without saying ; but let both previous crops be tilled ones, as for example, beans and corn, or potatoes and onions and there is enough of the personal equation to make the land unsuited for plot experiments unless the plots are confined to some one crop. When a crop is successive no portion of that experiment should grow upon old land. The marked influence of any leguminous crop is a case in hand. The soil from an old pea, bean or clover field when added even in small quantities to land new to such crops may double the yield. Turnips after turnips may be so diseased as to neutralize results of cultural treatment when compared with the same crop upon new land.

All prospective ground for a plot experiment ought to be uniformly in the same crop or succession of crops for a term of at least five years and fallow for the last season.

That the quality of the seed has an influence upon the results goes without further saying. In the early days of the writer's experiments the supply of seed would sometimes fail and that of another lot, but of the same variety would be used to finish the area. With bush beans, for example, it is very difficult to get the same strain of a variety from different dealers. The same is true of potatoes and nearly all sorts of truck crops. It is of considerable importance, therefore to purchase so liberally that there is no chance of one plot not receiving from the same lot of seed as all the others.

As it is our practice to grow two and even three crops as of peas and beans, during a season, it is imperative that enough seed be purchased in the spring to supply the needs of all the sowings and plantings of the growing season.

In planting and sowing there is a possible element of variation. After the seed bed has been made as uniform as possible throughout the whole area, the sowing or planting should be done by one man only and all upon the same day. One man may make the drills for the peas, turnips, beans or onions, but only one should do it for any given experiment. Another man may drop the seeds, but he should drop it all, unassisted by a second person anywhere. A third person may do the covering, but no one should help him. So important is this matter that it is the writer's plan to have the sowing or planting of a plot begun at such a time that it will be finished the same day. Some experiments have been ruined by beginning late one day and a shower at night prevents the finishing upon the next. He remembers well noting the untimely appearing of the beans upon one plot when a portion had been covered by one man and the remaining portion by another. Some will cover a little deeper than another and firm the soil excessively. There is in mind an instance where one row of onion seed was accidentally trodden upon and it soon became conspicuous for the good stand of vigorous plants. Another instance is with beans in which the writer was the guilty party. He was doing the covering, and at the call of the dinner bell, left a row and a half of the dropped seed to lie in the open row and exposed to the hot May sun. That row and a half was covered an hour later, and many others were planted in freshly-opened rows during the afternoon. When the young plants appeared two weeks or so later the row and a half made a very poor stand that was evident to every one who passed that way. The moisture of the open row was dried out and a highly heated and dried soil was placed upon the seeds instead of the cool moist soil of a freshly-opened row, and in this there seems to be the great difference in the plants. If I had not covered all the seed and knew it was all out of the same sack it would have been difficult to convince me that the cause was in the delay in covering the seed.

If it is so essential that the seed be covered by but one person through a whole plot, it goes without saying that plants should be set with even greater care. The writer has seen rows of cabbage, tomato and even strawberry plants that differed greatly from each other and the only point of variation was the person with the dibble.

Not more than one person is permitted to set the egg plants, for example, in an experiment plot at the New Jersey Experiment grounds. A second person may assist, but the ideal in all this work is when the same individual has brought the plants through all their vicissitudes of the seed bed, the potted plant and placed them in the field.

The Importance of Surplus.—There are so many contingencies that the experienced experimenter will have a large surplus in store in many ways. He should have some plots or portions of plots at hand in case land is needed at any time. There needs to be a surplus of any given seed for emergency. A crop may fail and a reseeding is advisable or the stand is so poor that a portion of the plot is made the basis of a new test, and the same old stock of seed is desired.

There should be a surplus of plants in the row so that they may be thinned to the desired distance after the chances are that there will be no further losses. Some unforeseen cut worm may take the corn or a bad smelling bug the squash vine and the need of surplus plants is evident.

Nowhere else does the old saying hold so strongly as in the plot experiment. "One for the cut worm, one for the crow; five to plant and three to grow." The writer has had too many plots prove failures from a lack of a stand of plants that might have been avoided by greater liberality of seed to let this point go by without more than a passing notice.

In the case of plants that are set out the rule is still more important. There should be a stock of eggplant or tomato plants far in excess of the number to be set, that the selection may be made in such a way as to give a uniform stand, fulfilling the requirements of the experiment. Such plants should be raised from the seed by, or under the eye, of the experimenter that he may feel sure of the kind and character of his plants. One would scarcely trust to ordinary commercial plants for use in a plot experiment. The seed might be mixed at the outset and an over stimulus might make the plants unusually tender.

In cultivation and all those processes which find a place under the term 'care of crop' one cannot be too serious. By a little carelessness here an element may be introduced that will spoil all the previous work. It is as essential, for example, that the whole plot be treated alike in the cultivation as in the sowing or planting. It is a good rule to never cultivate one row or plant unless the watch, and the clouds as well, indicate that there will be time that day for the same treatment of all in the experiment. If a half of a plot is hoed one day and the job finished the next, there are substantial reasons for inferring that the harvest of results will be scattered and scarcely worth the gathering together. There is a chance in all this work of being faithless to the ideals of the genuine experimenter who is constantly striving to eliminate all but the one point of variation in the test. For example, the wheel cultivator may be used twice in the row for a half of the plot and only once for the remaining portion and, while saving time it is robbing the experiment of its full value. A person who could permit such a thing is entirely unfit to occupy, much less fill, a position in a center of research, which we call in this country an Experiment Station. Far better to clean up the paths in the late afternoon than to make a beginning only upon a plot with hoe or cultivator.

It seems almost unnecessary to add any remark here concerning the necessity of keeping experiment grounds clean of weeds until the time is past when they can interfere with the results. Each plant in the crop should have its full soil and air space, and if weeds are permitted to contend for these essentials, the test, whether it be of fertilizer or distance or depth or any other thing, fails. Pigweeds and purslain and the whole list of weeds must be kept out of a plot experiment, and all results should read between the lines—these are with clean culture always understood. This is the cheapest as well as the only way.

There is a watchfulness demanded by the superintendent of field experiments that savors of the wisdom of the owl. He must also love truth beyond all else. Pardon me if I mention one of the elements in plot experiments that has been a great source of annoyance. It is the end plants and the outside rows. There ought not to be any, but it is not easy to get rid of them.

Their terrors came to me very forcibly last year in the old plot of eggplants, where the end plants, that is the outside row, all around the plot, was vastly better than those within, and demanded a separate record; but it was not made. With beans, an extra row has sometimes been planted upon the outside and rejected in the final results.

This problem of the end of side row only emphasizes what has gone before, namely the importance of placing each and every plant under precisely the same conditions as all the others. This is not done in case of the end plants and the results may be considered accordingly.

Troubles not to be Avoided.—There are dangers which all crop plants run. Stray animals may break in and destroy. Pigeons may get the first sowing of peas before germination. Moles may burrow under a plot and introduce a source of error. The hole thus made will turn the flow of an irrigating stream away from where it seems to go. The winds may blow down and destroy the branches and their fruit, and frosts sometimes bring an untimely end to a vigorous stand of plants. Thieves may break through and steal.

Weather we cannot control, but long-season crops should be started early. The enemies of the street need to be fenced out as securely as possible, but it is not easy to put a pad-lock upon a field experiment. Poison for the vermin, insecticides for the insects and fungicides for the diseases should be used with a judicious hand. One needs to guard his experiment area with infinitely more care than an ordinary orchard, farm or garden crop, for the fruits are an in-gathering of truth, as nearly as it can be obtained.

The Keeping of the Record.—This is the most difficult of all the operations connected with the successful issue of a field experiment. The conscientious superintendent will not trust to his memory for the details, nor write up the results from the information that is only in mind at the close of the experiment. He must keep a record of the stages of the crop from the time the ground is broken until the end of the harvest. This means during the more rapidly growing season the taking of almost daily notes as to growth of plants, etc., associated with rainfall and soil and air temperatures. The character of the notes will vary with the crop, but they, in any case, need to be full.

Many plans of note-taking have been devised, but of them all there is nothing better than a day-book for all the crops, from which the items are transferred upon rainy days and odd hours to the separate books for each particular crop. There is a journal, so to speak, for the beans, or each class of beans, as bush, dwarf lima and pole sorts, those of the peas, potatoes, tomatoes and cucumbers, etc. A set of small pigeon-holes placed upon the wall above the desk holds the crop-books close at hand. Note paper in pads has been tested, but the loose pages, while convenient for some things, are easily lost. Form-sheets with spaces for certain entries, and upon set dates with various schedules prove cumbersome, and from all the methods the writer has accepted the books as the most satisfactory.

Statement of Results.—The statement of results of plot experiments should of course be clear and comprehensive. The precise point to be held up to view will vary with the crop and the reason for the trial. In general it should be in percentage of increase, or of decrease, over the control plot where the single feature of the test did not obtain. For example, if the experiment is with a remedy for the pod spot of the beans the results admit of several methods of expression. They may be in terms of total weight of plants, of weight of marketable pods, or matured sound seed, or in percentage of diseases as compared with the control area. It seems to the writer that the chief point is the relative amount of marketable pods of the check plot. In other words, place in concise form the increase of the salable product, for this is the crucial test of the value of the fungicides. To this may be added the cost of the gain that the practicability of the spraying may be shown. As secondary matters the effect upon the whole plant and sundry other matters may be given.

But the end is not yet; to return to the increase of salable product. Shall it be shown in pounds or quarts or in number of pods. Snap beans are sold by the quart and it might seem the most natural method to state it in terms of quarts. In getting the results upon a plot it is easier to weigh the pods, and to assort out the spotted from the diseased pods it is simpler to count them. All these methods have been tested and experience suggests the counting as the best method. It is less subject to error in the harvest, there is no difficulty with fractions, the unit is a natural one, and shows upon the face of the results that each pod has been inspected. Neither weight nor measure do full justice to the disease for the spotted pods average much smaller than the healthy ones. Finally from the numbers the percentages are made up and the gain or loss is instantly applied to whatever unit of quantity that is in vogue.

The results must be calculated to a full stand of plants for both the trial and check plots. The absurdity of anything otherwise is evident with such crops as tomatoes or eggplants, but it is equally rational with bush beans or turnips. Sow the seed thickly and thin the crop to a given distance in the row, say six inches; count the plants at harvest for each row and if there are any missing allow for them.

Let the following serve as an illustration: A plot of ground is limed at the rate of 300 bushels per acre for the club-root in turnips. The adjoining plot has everything in common excepting the lime. The plants stand six inches apart and those upon the limed land flourish to the harvest time. Those upon the check plot languish and die from week to week and at the time the record is made only one-third are to be found. The roots are pulled and weighed, the roots weighed separately, assorted into those with and those without club-root and each lot counted and weighed. From the counts the percentages are made up, while the weights also go on record. One large unclubbed root will outweigh a dozen clubbed ones and the unfairness of weights as a basis for the final per cents. is apparent.

With the writer the results of his field experiments square usually to the line of disease, and the number of units of the plant product is the one that best conforms to the requirement of the case. With vegetable fruits as cucumbers, tomatoes, peppers, eggplants, it is the fruit and whether it is marketable or diseased. Tests have been made with the fruits left upon the plants until a single harvest day, as with cucumbers. The results may then become very striking to the eye; but the writer thinks the better way is to pick at the same intervals as for market and keep the record in the book. The results of the spraying may here be perhaps better estimated by counting the healthy and the diseased leaves and getting the percentage from these. The gain in marketable product is also given.

In root crops the writer has not always followed the plan herein advocated. Thus with sweet potatoes the series of experiments for checking the soil rot, started out five years ago with the pound as the unit and the plan has not been changed. It is not as easy and probably is not as accurate, owing to the fact that diseased roots are on the average smaller than healthy ones, because they are diseased.

In like manner in estimating the scab upon the round potato very scabby potatoes kept in a glass jar for the purpose and taken as one hundred per cent., have served for estimating the amount of disease of each pile at harvest time regardless of size or number, the crop being recorded in total yield in pounds and percentage of scab. For example weight of tubers 75 pounds, per cent. of scab 60; weight 84 pounds, percentage of scab 15.

The value of pictures is not to be overlooked as when the relative yields are placed in baskets, boxes or heaps. The superiority of the one treatment, whether of fertilizer, culture, pruning or spraying over another, in this way appeals to the eye in a vivid manner. Squares or circles upon the printed page will aid in the same way. There is, taken all in all, perhaps no better method of indicating the relative results than by the parallel bars, and they admit of many features in very small space. Thus three or more grades of product may be shown by different shadings or the relative amount of healthy and diseased fruit or vegetable. Like all similar devices, they admit of errors of statement and need to be constructed with great care and then should always form an adjunct of the text.

The personal equation needs to be reduced to the lowest terms and the experimenter should test this at frequent intervals by calling to his aid the judgment of the disinterested person, who is competent to arbitrate. A person with his eye fixed upon some point to be reached may be oblivious to side lights that play an important part.

The born experimenter we may expect in the next generation, but the present station workers needed to be made and that quite quickly. When the ideal truth searcher comes we shall be shown how best to work for the truth, the whole truth, and nothing but the truth.

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*MODERN PROBLEMS IN ACOUSTICS.**

THE subject of acoustics appeals in one or more of its phases to a wide range of people:

To the mathematician, for the laws of vibrating bodies furnish countless problems that tax his science to the uttermost;

To the physicist, to whom primarily the field belongs;

To the architect, whose business it is to design auditoriums fitted for hearers as well as for spectators;

To the anatomist and physiologist, who finds in the organ of hearing a wonderfully complex structure that is incomprehensible without the aid of acoustical principles;

To the psychologist, who investigates the operations of the mind concerned in the hearing of sound;

To the instrument-maker, who must furnish the musician the means of expression and help him develop them;

To the musician, who cares to know the historical development and the foundations of his present art;

To the ethnologist, who recognizes music as one of the most important expressions of the life of a people; and lastly,

To all intelligent men who find with the Roman 'nothing of human interest alien to them,' and realize that a subject of such world-wide, time-long, interest as music may be studied profitably even by those who are not numbered among musical performers. For they appreciate the fact that here, as everywhere, the ability to learn *why* the alien does what he does, to enter sympathetically into his thought and see through his eyes, is the subtle power which distinguishes culture from mere knowledge.

In accordance with the custom of these Reports we are to take a bird's-eye view of recent progress in the science of acoustics.

I. In the history of acoustics two names are pre-eminent: Chladni, the text-book writer, who united to wide knowledge of the subject great ingenuity and experimental skill; and Helmholtz in whom there was a unique combination of mathematician, physiologist, physical experimenter and musician. His *Sensations of Tone as a Physical Basis for Music* published (in German) in 1863, and his monographs summed up in it, contained enough in each of these four lines to make one famous. The book has for nearly forty years dominated the thoughts of most people who believe that the science of acoustics has anything to teach musicians. Still it is significant that musicians have largely refused to recognize its sway, some showing crass ignorance in their comments, others making it clear that there is something in

* A Report from the Committee on Physical Science presented to the Washington Philosophical Society by Charles K. Wead.

the appeal of music to the human mind and heart that eluded his philosophy.

Though this ancient question of the physical basis of music is still a problem, there is time here to note but two points, and these have reference rather to the mode of attack than to the problem itself: (1) What scholarly musicians of to-day think of as music differs to an important extent from what was in Helmholtz's mind forty years ago as truly, though not as widely, as it differs from mediæval music; (2) Materials available in recent years for the historical study of European and Oriental scales disclose several consciously-used principles of scale-building which could not result in the diatonic or harmonic scales for which Helmholtz's overtone and resultant-tone theory furnished so strong a justification. Perhaps the greatest value of the book has been its stimulus to investigation in many fields, especially in the psychology of music; yet in spite of all our modern progress the greater part of the work remains as indispensable as ever.

II. Since the publication of Hemholtz's work the most noteworthy things in connection with Acoustics have been:

1. The multiplying and perfecting of methods and instruments, especially by König and Appunn; the development of the phonograph; the application of photography.

2. The publication of Rayleigh's mathematical *Theory of Sound;* of the ten volumes of the *Vierteljahrsschrift für Musikwissenschaft,* full of scholarly monographs on the musical and historical side; and of Ellis & Hopkins' researches on musical scales.

3. The developments in musical instruments (especially the piano), so giving us instruments of more accurate intonation and of greater power, and unfortunately driving out the older soft-toned instruments.

4. The general introduction into the household of the piano or reed organ, often leading psychologically to the conviction that there can be no music without harmony.

5. The building-up of several great collections of musical instruments from various lands and times, and the publication of books and monographs based thereon.

6. The accumulation of a vast amount of observations and experiments in the field of music-psychology.

III. Confining our attention now to Physical Acoustics, we may consider a little more in detail some of the recent advances that can readily be grouped together.

The *Velocity of Sound* in free air has been shown to increase greatly for very intense sounds, and has been measured in air compressed up to 100 atmospheres; the velocity in air confined in tubes is found to be a function of the diameter and nature of the walls, and of the pitch. The velocity in solids has been much studied, and measured even in such soft bodies as paraffin and rubber.

The *Frequency of Vibration* in specially favorable cases is now measured to within a few parts in a million; so the writing tuning-fork is now the usual means of dividing a second, say into 100 parts; but in ordinary cases, especially where the pitch is high, or the sound weak or of short duration, errors of some per cent. are frequent. Quite recently the sets of high forks made by Appunn for physiologists have been found to be extravagantly in error; but as partial compensation for the disappointment the science has been enriched by new experimental methods.

Of extreme importance to the modern physicist is the question of the energy involved in any movement. The experimental study of *Intensity of Vibration* began, I believe, with Töpler and Boltzman's ingenious optical determination, in 1870, of the actual variations in density in the air of a sounding organ pipe, and the distance at which it could be heard, and so the energy per second required at the limit of hearing. More recently a Swedish experimenter found, by periodically thrusting a thermopile, mounted on a tuning-fork prong, into a sounding pipe at the node, a rise of 0.1° C., due to the adiabatic compression. Since 1870 experiments on the energy of organ pipes, etc., have been multiplied and refined. Similarly, determinations on the intensity of telephone currents and the movement of its disc have testified to the incredible sensitiveness of the ear. An amplitude of vibration of air particles of only one fifteen millionth of a millimeter in the region of 440 d. v. produces sensation.

Other investigations have traced the expenditure of the energy once stored in a vibrating mass; so the rate of damping of forks under various conditions has been observed; also the dissipation of energy in a resonator and the decay of sound in free air: it has been noted that a sound reflected repeatedly through a tunnel changes in quality, owing to the more rapid absorption of the overtones of high pitch. A contrary analytical effect is observed in some cases of echoes, as from a forest, where the sound of the voice seemed to come back raised an octave.

The relative absorbing power of various fabrics has lately been measured by Sabine. From his data I calculate that for a note of 256 dv. 0.33 of the energy falling on a sheet of hair felt one-half inch thick is absorbed.

A few instruments have been devised to produce a tone of definite reproducible intensity, and other instruments to indicate or measure the intensity of vibration at a given point. In Wien's beautiful manometer the minute yielding of a part of the wall of a resonator is measured by mirror and scale to one five hundredth part of its maximum amount, while the absolute value of the scale readings is determined to within a few per cent.

The study of *Form of Vibration* or *Quality of Sound* has been prosecuted both synthetically and analytically. König many years ago challenged Helmholtz's conclusion that the quality of sound depended only on the strength of the overtones, not on their relative phase; and he invented his wave-siren to prove his position. In this instrument the flow of air through several slits is carved into waves by several rotating discs, whose edges are cut into harmonic curves. More recently he has greatly perfected it, and attempted to meet various criticisms made against his earlier work; but so many lines of argument support Helmholtz's view, that I do not think this brilliant attack will generally be admitted to have conquered the field. A more reliable means of synthesis than the wave-discs is found in Appunn's sets of organ pipes; these furnish a great number of harmonics of one fundamental, and for each harmonic there are two pipes, a weak-toned and a strong-toned one.

Analytically the problem of form of vibration has been attacked in various ways, especially by photography. If the vibration to be examined is in the air either the König's flames connected to a set of resonators may be photographed, or a little mirror on a convenient speaking tube may throw a spot of light on the sensitive plate. If the sounding body is a wire, it is mounted to vibrate before a transverse slit through which light falls on the sensitive surface moving parallel to the string. Compound curves produced in either way are then subjected to harmonic analysis. In passing it may be noted that Mach obtained a photograph of a sound wave in air as far back as 1888.

The superposition of two vibrations has been further studied with reference to the pitch actually observed when two notes are beating; the old theory of combination tones has been rudely shaken and their objective existence proved experimentally in certain rare cases. Mechanical superposition of harmonic motions has been obtained by many elaborate forms of harmonographs or curve tracers.

Both physicists and physiologists have devoted much attention to the study of the complex curves due to vowels and speech-sounds, working especially by aid of the phonograph.

Two or three matters of industrial as well as of scientific importance may also be noted, viz, the enormous development of speaking instruments—phonograph, graphophone, gramophone; the adoption by the Piano Makers' Association of the U. S. of the French standard tuning-fork giving A = 435 d. v.; and many improvements in organ pipes and reed stops that show a practical control over the wind sheet such as the older builders had not obtained.

IV. And now what are some of the most important *problems remaining to be solved?*

1. In pure physics: The simplification of the means for the precise determination of pitch in the ordinary practical cases; the establishment of convenient standards of intensity, and the perfecting of experimental means of measuring intensities; the development of means for the thorough analysis of sounds.

2. In connection with instruments: The thorough study of the action of the sounding board of a piano; of reeds as actually used in common instruments, and of the laws of the perforated tube as applied in flutes, etc.; the determination of the quality of tone produced by our common instruments under the conditions occurring in practice. Some day it will be possible to make as thorough and scientific an examination of a musical instrument as it now is of a steam plant or a dynamo. On all the points just noted current statements are inadequate, for the art is now so developed that the knowledge of the laws of vibrating bodies to the first approximation only is insufficient for future guidance.

3. In connection with architecture: the determination of the reflection or absorption coefficient of the various materials used in building for inside walls, with the numerical evaluation of the several factors that influence the acoustic properties of an auditorium; and the acoustic survey of auditoriums, showing the intensity of sound at all points where hearers might be placed.

4. In connection with practical life, the physicist finds the important problem of fog signals still unsolved.

5. On the side of psychology and music there may be named the further study of the capabilities and deficiencies of the human ear; the influence of instruments on musical conceptions; the historical, psychological and practical nature of the scales in use among various peoples; these branches bring our material study into intimate relations with human development.

V. In view of the manifold interests that center in the subject of acoustics, scientific and commercial, æsthetic and utilitarian, specific and general, it seems strange that neither by endowment in connection with a University, nor by government appropriation has provision been made for a well-equipped acoustical laboratory; for here the same reasons apply that justify similar expenditures for so many other branches of science, viz, that the subject is of large importance, either industrially or in its relation to past and present human activities; that the results of investigation would be of value to the community at large, being far wider than could be monopolized by the investigators; that the necessary expenses are beyond the means of the individual experimenter; and that nowhere in this country or the world is there any systematic exploiting of this field.

CHARLES K. WEAD.

OPPORTUNITIES FOR BIOLOGICAL STUDY IN PARIS AND THE REQUIREMENTS FOR THE NEW DOCTORATE.

It is not probable that many Americans, going to France for study in science, will think of locating elsewhere than in Paris. For while there are fourteen French universities outside of Paris, most of them well equipped for scientific work and holding the names of eminent men in their faculties, yet Paris with her numerous scientific institutions, with her unsurpassed facilities for research, with her array of famous biologists, shines with a refulgence which draws the eyes from the rest of France. But the scientific life of Paris is not and ought not to be the only attraction for the student seeking foreign study. The stores of art, the libraries, the historical associations, the political heart of the French Republic are all attractive to the enquiring American, and should each leave its impress upon him.

A very brief description of the institutions in Paris offering opportunites for biological study will indicate to some degree the extent of the field, which is as free to foreigners as to native Frenchmen. These institutions are five in number : the University, the College of France, the Museum of Natural History, the Pasteur Institute, the School for Higher Studies. All of these with the exception of the Pasteur Institute are to a greater or less extent controlled and supported by the Goverment.

I. THE UNIVERSITY OF PARIS.

The school of letters and of pure science of the University is denominated the Sorbonne. The buildings of the Sorbonne have been reconstructed and greatly extended during the past decade, so that the new Sorbonne is now composed of an immense collection of beautiful auditoriums and laboratories, all in a compact but well-lighted mass, located in the heart of the city, in the midst of the famous Latin Quarter. The laboratories are well appointed, displaying the usual equipment of modern institutions of a like nature. Students here, as in other countries, receive the attention of the director of the laboratory, and the aid of a corps of subordinates. In botany, the professors are Bonnier and Daguillon; in zoology, Lacaze-Duthiers, Delage, and Perrier; in physiology, Dastre.

Besides the Sorbonne, there are two institutes belonging to the University, primarily professional, but doing a considerable amount of purely scientific work. These are the Medical School and the Pharmacy School. The former has its buildings five minutes' walk to the north of the Sorbonne. Among the famous names in its faculty may be mentioned that of the physiologist Langlois.

The School of Pharmacy is nearly a mile to the south of the Sorbonne, occupies a beautiful site on the Avenue de l'Observatoire, and has fine buildings and a flourishing botanic garden of about one acre in extent in the court of the quadrangle. The school is attended by over 1700 students, this number being nearly equal to the number of students in letters at the Sorbonne, and also equal to the number in pure science. The professor of botany at the School of Pharmacy is Guignard, well known to American students for his contributions to vegetable cytology.

Should the student desire to pursue his study of biology during the summer, he may follow Bonnier to Fontainebleau or resort under other professors to one of the marine stations.

II. THE COLLEGE OF FRANCE.

In a square adjoining the Sorbonne is the Collège de France, with an organization independent of the University, yet working in harmony with it. This institution has its own lecture rooms, laboratories, and faculties, and its professors are equally famous with those of the University. Botany is not included in the curriculum of the College, but in zoology there are Balbiani and Ranvier, and in experimental psychology, Ribot.

III. THE MUSEUM OF NATURAL HISTORY.

To the biologist, of perhaps greater interest than the Sorbonne, or the Collège de France, is the so-called Museum of Natural History. It is probably unnecessary to say that this noted institution is a great inclosure of approximately seventy acres, containing auditoriums, laboratories, museums, a zoological garden, and a botanic garden. The enclosure is more commonly known as the Jardin des Plantes. It is located on the south bank of the Seine, only ten minutes' walk from Notre-Dame. This spot is consecrated by the memories of such great men as Buffon, Jussieu, Lamarck, De Candolle, Cuvier and Milne-Edwards père. Its laboratories are to-day well directed by Van Tieghem, Bureau, Bornet, Deherain, and Maquenne in botany, by Milne-Edwards fils, Vaillant, Bouvier, and Perrier in zoology, and by Gréhant in general physiology. Besides the three subjects just named, the Jardin does work also in anthropology, geology and mineralogy. The roll of the scientific staff bears twenty names.

The opportunities for biological study here are unsurpassed. It is true that both the zoological and the botanical gardens come to have a shabby aspect in a dry summer, and suffer for lack of water, and the plants in the glass-houses are so crowded that they are unhealthy from insufficient light. But the living plants and animals are so numerous and accessible, the museums are so extensive, the laboratories are so adequate, and the library so full, that an investigator may be assured of all that equipment can supply. The museums of zoology and of comparative anatomy are probably the best in existence. The mounting and the grouping of the objects are elegant and effective.

IV. THE PASTEUR INSTITUTE.

The Institut Pasteur is located a mile or more to the west of the Sorbonne. In the present Institute, Pasteur did not live long to enjoy his enlarged quarters. His famous discoveries were made in a little building still standing in Rue d'Ulm near the Panthéon. In 1888 the present laboratory was opened, but Pasteur died in 1895. His tomb rests in a crypt beneath the building. The present Institute has already proved itself too small, and there is now nearing completion across the street an annex, larger than the present laboratory, and costing $400,000. This Institute is preëminently for investigation in bacteriology, fermentation, and biological chemistry, and for the preparation of serum for the prevention of disease. One will find in this great Institute excellent provision for research, yet not great complexity of means. Here work Duclaux, Roux, Chamberland, and Metchnikoff, names well known to biologists.

V. THE SCHOOL FOR HIGHER STUDIES.

The École Pratique des Hautes-Études is *sui generis*. This institution has no buildings of its own, but designates noted men anywhere in Paris, and in some marine laboratories, as members of its faculty. All its work is that of the seminar and the laboratory. Some of its professors are men with private laboratories, while some receive students in their own homes. The work of this institution is gratuitous to the student, and no degrees are conferred. The organization attempts to make available for research all the public and private resources of the great city. For its work in biology, it designates as its professors, the professors in the University, in the

Collège de France, in the Museum of Natural History, and in the Pasteur Institute. Admission to work is a matter of agreement between professor and pupil, the latter having to demonstrate his competency to the professor.

The foregoing brief account may suffice to show that the scientific institutions of Paris in equipment of laboratories and in facilities for research are the equal of those of any nation, and what is still more important than equipment, that the foremost scientists of France are professors in these institutions.*

ADMISSION TO RESEARCH. THE DOCTORATE OF THE UNIVERSITY.

A student is admitted to lectures in the University with no more requirement than the presentation of an admission card which is obtained gratuitously on application. Savants, French and foreign, may be admitted free to work in laboratories, on the recommendation of the dean or director or professors.

The ordinary investigator or student who is not a candidate for a degree, must present his certificates from the institutions where he has studied; and if these are acceptable, he must then matriculate with an annual fee of 20 francs. Besides this, he must pay an annual library fee of 20 francs, and a quarterly fee of 22.50 francs for each biological laboratory in which he works.

* A considerable amount of information concerning the subject discussed in this paper may be obtained from two pamphlets recently issued. The first is the *Guide illustré de l'étudiant etranger à Paris*, to be obtained from any bookdealer of Paris for 1 franc, 50 cent. The second is *The Universities of France*, published by the Franco-American Committee, to be obtained from Professor Michel Bréal, 70 Rue d'Assas, Paris. Professor Bréal is also prepared to answer any inquiries relating to study in France.

Some of the information contained in the last named pamphlet can be found in the Report of the U. S. Commissioner of Education for 1897–98, Vol. I., p. 749.

The laboratory investigator, not a candidate for a degree, will therefore pay annually in fees to the University 26 dollars.

In 1898, the French Government gave the French universities permission to establish a new degree—the university doctorate. This degree corresponds with the German and American doctorate. It differs from the usual French doctorate in that the latter requires longer to obtain and confers various privileges. The new university doctorate confers no privileges.

To enter upon a candidacy for a university doctorate in the University of Paris, one must present certificates showing his attainments. Graduates of good American colleges will generally find their credentials sufficient. The petitioner having been accepted, inscribes his name in the register, pays an annual library fee of 20 francs, a quarterly inscription fee of 20 francs, and a quarterly fee of 22.50 francs, for each laboratory in which he works.

If the foreigner enters on a scholastic level with the graduate *lycée*, *i. e.*, on a level with the French bachelor, he must complete two *superior studies* and a thesis. The superior studies correspond to minors, and may be selected from seventeen departments of learning. The minimum time for these two minors and the thesis is two years. But the candidate who can present and pass examinations in equivalents to these two superior studies may have the time of residence required for the doctorate reduced to one year. The candidate must present a thesis embodying original research, must defend this thesis before an assembly of professors, and must answer questions on other subjects proposed by the examiners. The examination fee in pure science is $60; in medicine, $135; in pharmacy, $186. The candidate must print his thesis, and furnish the University with 150 copies. The total fees, besides the cost of printing the thesis, will be therefore about $100 if the student takes one year and about $150 if he takes two years in preparation for the doctorate. In comparison with this, one pays in science about $70 for one year and $120 for two years at the University of Leipzig.

Especial mention should be made of the fact that a student may pursue his work for the doctorate, not only at the Sorbonne, but instead at the School of Pharmacy, at the Jardin des Plantes, at the Collège de France, at the Pasteur Institute, or under the auspices of the École pratique des Hautes Études. That is to say, all these great and independent institutions are affiliated with the University, so that the University gives credit for their work. Thus a man who wishes to make his major with Bonnier at the Sorbonne, or with Van Tieghem at the Jardin des Plantes, or with Guignard at the Ecole de Pharmacie, or with Duclaux at the Institut Pasteur will find these various routes to the doctorate equally open. In all of these institutions the lectures are wholly free and gratuitous. In each of them, except in the Institut Pasteur, the fees of any one laboratory for a year are less than $20 dollars. In the Institut Pasteur the fee is $10 per month.

One is safe in saying that in no other city in the world can be found such a brilliant array of professors and laboratories. Truly France has shown a spirit of liberality toward educational matters unsurpassed by any country.

When, however, one studies the register of the University of Paris, one is struck with amazement at the smallness of the number of names of foreign students, especially with the smallness of the number of Anglo-Saxons. In the year 1897–98, the total registration of the University was over 14,000. The total number of Americans present was 44. Of these 44, 28 were in the college of letters, and hence we may assume that the most of them were in the University for the study of the French language. There were only 6 Americans studying pure science, 6 studying medicine, and one studying pharmacy.

The University of Paris contains, it is safe to say, nearly all the Americans who are studying in the universities of France. But compare the number of Americans who are studying in German universities and technical schools. The report of the U. S. Commissioner of Education for 1897–98 shows a registered attendance of 514, and estimates the total number as being over 1000. The registered Americans in Austrian institutions numbered at that time 106; and in Swiss institutions 65. In the year 1895, the University of Berlin had 4018 matriculates, of whom 159 were Americans; Leipzig 2798, of whom 53 were Americans; and Göttingen 878, of whom 30 were Americans. In the same year, Paris, with an enrollment of 10,951, had only 32 Americans.

Moreover the number of Americans in the University of Paris seems not to be on the increase, though the total number of students there is constantly rising. Thus in 1891, there were 45 Americans there; in 1896, 38; in 1897, 51; and in 1898, a recession to 44.

Naturally one pauses to enquire why Americans are so loth to choose Paris as their place of study. It cannot be due to the expense of living; for Paris is scarcely more expensive than Berlin or Munich. It cannot be due to the university fees; for, though for laboratory work and for the diploma, the expense may be somewhat greater in Paris, the expenses for lectures in Paris are nothing, and hence for the student in studies other than natural science, the university fees are lower at Paris than in Germany. The discrimination against Paris cannot for the most part be due to the previously existing requirements for the doctorate; for not half the Americans who go abroad for study seek the doctorate.

It is probable that the most potent influence turning the tide toward Germany rather than toward France, at least for the sciences, is to be found in the attitude of the American professors themselves, in the advice they give their students. This, however, cannot be held as an ultimate explanation.* Why do these men in American universities advise their students to go to Germany? Why are the scientific libraries in this country so much better stocked with German literature than with French literature? I cannot help the feeling, though I have no statistics, that on the whole Germany has, within the past forty years, produced more scientific men and more scientific literature than has France. It is doubtless true that we neglect unduly French scientific literature in this country. But it is probably also true that to-day, as forty years ago, we justly look to Germany as the seat of the leading spirits in the progress of biological science.

As a second reason cited by some to account for the lack of American interest in French universities, is the apparent distance placed by the French professor between himself and his students.

Finally we have the possible barrier of the difference in race, with all that this implies. Science is supposed to know no racial boundaries; but even scientific men are influenced by the hereditary and acquired ideas and ideals of their race.

FREDERICK C. NEWCOMBE.

ANN ARBOR, April 14, 1900.

* As bearing on this topic, see 'Notes on the History of Foreign Influence upon Education in the United States,' by Hinsdale. Report U. S. Commissioner of Education, 1897–98. Vol. I., p. 591.

THE SENSES OF PRIMITIVE MAN.†

THERE is a general belief that savages are able to see things that are invisible to the European, and the question is how far this alleged superiority is due to power of observation or to actual acuteness of vision. For the elucidation of this and many other problems in experimental psychology exact investigation is necessary on savages under natural conditions. This Dr. Rivers was enabled to do during the recent expedition to Torres Straits and New Guinea, which was organized by Dr. A. C. Haddon. Although the Torres Straits islanders are not now savages, they may fairly be described as primitive since a generation ago they were naked savages. The greatest amount of work was done on Murray Island, and the people readily allowed themselves to be experimented upon. The conditions were, as a whole, very favorable, the great majority of the natives investigated did their best as is evidenced by the smallness of the mean variation in most of the quantitative investigations. The Murray islanders are dolichocephalic Papuans with a very dark skin and the typical black frizzly hair. They also have the characteristic excitable Papuan temperament.

The visual acuity of these people was found to be superior to that of normal Europeans, though not in any very marked degree. The visual powers of savages, which have excited the admiration of travellers, may be held to depend on the faculty of observation; starting with somewhat superior acuteness of vision by long attention to minute details coupled with familiarity with their surroundings, they become able to recognize things in a manner that at first sight seems quite wonderful. But such exclusive attention as they have learned to pay to objects of sense appears a distinct hinderance to the development of the higher faculties. This view might at first seem paradoxical, since sense impressions are the foundation of the intellectual processes; but, on the other hand, the intellectual superstructure must suffer if too much

† Abstract of three lectures delivered by Dr. W. H. R. Rivers, before the Royal Institution of Great Britain, London, on Jan. 18, 25, and Feb. 1.

energy is expended on the sensory side. In the same way the savages lack of æsthetic appreciation of scenery may be accounted for, since distinctness of detail seems sometimes antagonistic to æsthetic enjoyment. The commonest defect of eyesight among Europeans is myopia, but this was found to be almost completely absent among savages. The opposite condition, hyperopia, which is apparently the normal condition of the European child, was very common among them, and, as it involved accommodation for distant vision, it is possible that the apparent visual acuity of the savage had something to do with a power of quicker and more exact accommodation acquired by constant practice. Some observations were made on vision at low luminosities, and while these were not altogether satisfactory they seemed to indicate that the natives of Torres Straits were able more quickly to adjust their eyes for darkness after light, and to see better in the dark than Europeans. Their binocular vision was normal.

An investigation of the color sense is important in studying the relation between language and ideas. There is a marked paucity in the color vocabulary in the Homeric poems and other ancient writings, Gladstone, and later Geiger, argued from this that there was an actual deficiency in color sense among the ancients and that an evolution in color sense has taken place within historical times. Dr. Rivers has carefully studied the color nomenclature of various races. The simplest he found was among some North Queensland natives, a number of whom had only three color terms. The next simplest was at Kiwai Island, at the mouth of the Fly River, British New Guinea, where there was no name 'for blue apart from black.' The two Torres Straits languages, Murray Island and Mabuiag, were more extensive. In these four vocabularies four stages may be seen in the evolution of color languages exactly as deducted by Geiger, red being the most definite, and the colors at the other end of a spectrum the least so. It was noteworthy, too, that the order of these people in respect to culture was the same as in regard to development of words for colors. The Eskimo, Dr. Rivers observed, differed radically from the languages of the tropical peoples he had examined in possessing an extremely well developed color vocabulary. The epithets used for colors in Homer were discussed and the conclusion was arrived at that the features of his color language were essentially of the same nature as those found among primitive peoples of the present day.

Speaking of the objective examination of color sense in Torres Straits, Dr. Rivers said the people show no confusion between red and green, but they did between blue and green. The investigation of their color names, he thought, showed that to them blue must be a duller and darker color than it was to us, and indeed the tintometer had afforded evidence of a distinct quantitative deficiency in their perception of blue, though the results were far from proving blindness to blue. Dr. River's then discussed some of the objections that had been urged against the theory of an historical evolution of color sense, coming to the the conclusion that it was not to be lightly put aside, though it could not be regarded as fully demonstrated. Next he considered some of the factors that determine the special characteristics of primitive color language, giving some instances, from widely separated parts of the world, in which names of colors seemed to be derived from the same natural objects.

None of the Torres Straits natives were superior in acuteness of hearing to one member of the expedition, while the majority were inferior. No great weight, however, could be attached to the observations, because all the men were divers—an occupation that certainly damaged the ears to some extent. To investigate their range of hearing a Galton's whistle was used, and it was found that they could hear very high notes.

Their sense of smell was tested by means of a series of tubes containing solutions, of varying strength, of odorous substances like valerian and camphor, and the results, while not altogether satisfactory, tended to show they had no marked superiority in this respect over the members of the expedition.

With regard to taste it was very difficult to get information, as the natives, naturally enough, did not like strange objects being put into their mouths. One fact, however, was noticed, which was interesting when it is remembered that sweet and bitter are probably our most definite taste sensations, and that was the complete absence of any word for bitter. For the sense of temperature the *data* were very scanty, but it was found that the natives had points on their skin specially sensitive to cold exactly as is the case with Europeans. As to touch, when tested to see how close the points of a pair of compasses must be put on the skin before they ceased to be felt as two, their sensitiveness was in general better than that of the members of the expedition. There is a consensus of opinion that savages are less sensitive to pain than Europeans, but there is always the doubt whether they are really able to bear pain with fortitude. However, the conclusion that the Murray Islanders were distinctly less sentitive than the European in the expedition was supported not only by their subjective statements, but also by objective tests depending on the condition of the skin pressure.

In the discrimination of weight it was curious that these natives who had no abstract idea of weight, and no word to express it, and who, moreover, could have had no practice, were more accurate than a practiced European.

Finally Dr. Rivers, while commenting on the defective knowledge of some of the senses he had treated, and on the absence of comparative *data*, concluded that, in general, the sense organs of the savage were not markedly superior to those of the normal or average European, and that the recorded instances of apparent extraordinary acuteness were to be explained by his habits of observation and specialized knowledge.

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*OLIVER PAYSON HUBBARD.**

Oliver Payson Hubbard was born in Pomfret, Conn., March 31, 1809, and died in New York, March 9, 1900. After graduating at Yale College in 1828, he remained in that institution as assistant to Professor Silliman until he began his study of medicine, which he completed in 1837, when he received the degree of M.D. from the South Carolina Medical College, at Charleston.

Prior to his graduation in medicine, he was made professor of chemistry, pharmacy, geology and mineralogy in Dartmouth College. In 1871 the chair was restricted to chemistry and pharmacy, and no longer required his full time, so that he was able soon afterwards to make New York his home during much of the year. In 1883 he felt that he had already passed the age when one should retire from a professorship, and resigned his position, becoming *professor emeritus*. Thereafter he remained in New York City.

His youthful love of science led him to Yale, that he might study under Professor Silliman, then the prominent teacher of science in our country. His first publication, entitled 'Geological and Mineralogical Notices,' having reference to localities in northern New York, appeared in the *American Journal of Science* in 1837, and was followed in 1838 by a somewhat more elaborate article upon the White Mountains.

* Read before the meeting of the Section of Geology and Mineralogy of the New York Academy of Sciences on April 16, 1900.

He attended the 1841 meeting of the Association of American Geologists and Naturalists and read a paper of capital importance upon the slates of Waterville, Maine, in which he discussed the markings upon the slates and indicated their organic origin, which he regarded as proving their great age. He was present also at the third meeting and took a prominent part in the discussion of the 'drift' so that he was appointed member of the committee to prepare a report upon that subject for the next meeting. He was elected secretary of the Association for 1843 and, with Benjamin Silliman, Jr., served in the same office for 1844. His duties at Dartmouth were exacting, so that for many years he published few extended papers, but he made many brief communications to societies, all of which were characterized by keen discrimination and many of them were important contributions.

Doctor Hubbard joined this Academy in 1874 and at once became so active that when Mr. Browne, who had been Recording Secretary from 1839, resigned in 1875, Professor Hubbard was chosen as his successor. He retained this office until 1885, when he became Vice-President. At the death of Doctor Newberry in 1892, he was made President, but he served for only one term, declining re-election because of his advanced years. From 1874 until 1893 he rarely failed to attend the meetings, when in the city, and he always presented something of interest bearing upon matters under consideration. His manner was courteous to the last degree and he understood well how to discuss without disputing.

Professor Hubbard's individuality was very decided; though so gentle and considerate in his manner, he always held positive opinions and, when necessary, did not hesitate to express them. His shrewd common sense made him a good counsel and his advice was sought in many directions. He was a member of the New Hampshire Legislature in 1863–4, but one year's experience in that kind of work sufficed and he declined to be a candidate for re-election. His quiet humor and his store of reminiscences made him a delightful companion. He retained his mental vigor to the last and only two months ago he published an article correcting errors in a recently published work. When ninety years old, he attended the New York meeting of the Geological Society of America and remained throughout an afternoon listening to severely abstract papers, with as much interest, apparently, as though he were just beginning his work.

Professor Hubbard was almost the last link binding our time with that of the early geologists. Hall and Dana died within the last half decade and there remain only Boyé and Lesley of those who attended the earlier meetings of the Association of American Geologists. He passed away in a ripe old age, his life full of good works and his name absolutely unstained. This Academy owes him much, and here his name should be cherished.

J. J. STEVENSON.
ALEX. A. JULIEN.

SCIENTIFIC BOOKS.

The World and the Individual. Gifford Lectures delivered before the University of Aberdeen. First Series; The Four Historical Conceptions of Being. BY JOSIAH ROYCE, Ph.D., Professor of the History of Philosophy in Harvard University. New York, The Macmillan Company. 1900. Crown 8vo. Pp. xiv+588.

The purpose of the Gifford Lectures at the four Scottish universities is now understood pretty well even in foreign countries. The Deed of Gift defines it as the "Promoting, Advancing, Teaching and Diffusing the study of Natural Theology, in the widest sense of that term"; and directs the "lecturers to treat their subject as a strictly natural science, without reference to or reliance upon any supposed special, exceptional or so-called miraculous revelation." "I wish it considered just as astronomy or chemistry is," the Founder writes. In these circumstances, readers of SCIENCE might expect to find many matters of direct interest in the lectures, especially when they recall that courses have been delivered by Sir George Stokes, Sir Michael Foster, and Professor William James, or that Helmholtz and Lord Kelvin were requested to accept election. It so happens, however, that Natural Theology has been more and more transformed from the semblance of its old self by Metaphysic, during the nineteenth century, and some of the lecturers, like the Master of Balliol and Professor Ward of Cambridge University, and now Professor Royce, attach principal importance to this aspect of the inquiry. Thus, although Mr. Royce's 'Supplementary Essay,' on the One, the Many, and the Infinite, cannot but attract mathematicians, especially such as are concerned about the theory of numbers, his book does not appear, otherwise, to contain much matter of direct moment for readers of this JOURNAL. I say 'appear' advisedly; for here, as so often, appearances happen to be deceitful.

Although the whole of Mr. Royce's work is metaphysical, and sometimes very technically metaphysical, there are but two of the ten lectures (i and iv) which possess little direct bearing upon that scientific view of the universe formulated almost entirely since the time of Laplace. Further, lectures iii, v, vi, vii, viii and ix are of vital importance for contemporary conclusions regarding, not what man *can* know, but what he *does* know—must know in the nature of the case. The titles of these discourses are as follows:—the Independent Beings—a Critical Examination of Realism; the Outcome of Mysticism, and the World of Modern Critical Rationalism; Validity and Experience; the Internal and External Meaning of Ideas; the Fourth Conception of Being; Universality and Unity.

Everyone knows that the sciences, not excepting psychology, presuppose a dualistic attitude towards human experience, for the very simple and very defensible reason that this best consorts with the impartiality necessary to obtaining the most accurate results. So long as he confines himself to his observations and experiments, no scientific man doubts that there is a world of real being existing on its own account in entire independence of thought or its processes. Nevertheless, and curiously enough, he also never doubts—for here lies the whole vitality of his quest—that he can obtain valid knowledge of this foreign sphere. Further, and still more curiously, he is perfectly willing to accept the conclusions of others as valid—co-operation being one leading note of contemporary science. In a word, paradox though it be, dualism and the negation of dualism are equally presuppositions of detailed scientific inquiry. Hence originates what Mr. Royce calls realism, the dogma critically examined and conclusively shown to be untenable in his third chapter. But, while this dualistic metaphysic—unconscious albeit—could remain complacent and, but for Berkeley, comparatively undisturbed, throughout the domination of what has been aptly called the astronomical (or molar) view of the universe, more modern researches, particularly in the field of physiology, gave it the lie direct and from the strictly scientific side. Physiological physics set dualism somersaulting. As Helmholtz said: "I hold that to speak of our ideas of things as having any other than a practical value is absolutely meaningless. They can be nothing but symbols, natural signs, which we learn to use for the regulation of our movements and actions. When we have learned to read these symbols aright, we are able with their aid to direct our actions so that they shall have the desired results; that is, that the expected new sensation shall arise." Or, as Huxley put it, even more pointedly: "All that we know about motion is that it is a name for certain changes in the relation of our visual, tactile and muscular sensations. . . . It is as absurd to suppose that muskiness is a quality inherent in one plant as it would be to imagine that pain is a quality inherent in another, because we feel pain when a thorn pricks the finger." Here we discover the root of that Critical Rationalism, so popular with scientific men during the past generation, and now subjected to such merciless exposure in Mr. Royce's fifth and sixth lectures. The other lectures, already noted as of importance to scientific readers, really deal with the metaphysical conclusions which modern inquiry, broadly viewed as a whole, most fully warrants. They constitute the first attempt in the United States, so far as I know, to supply a reasoned account of first principles from the standpoint—the only reasonable, and therefore the only defensible one as I think—that human experience is a closed circle, and that if it is to be justified at all, justification must proceed from within this circle.

This is not the place to attempt an estimate of Mr. Royce's contribution to 'natural theology' (*i. e.*, philosophy of religion); moreover, it were more just not to anticipate his second series of lectures, in which he promises to apply his principles. I wish, in conclusion, to draw the attention of mathematicians to the importance of the Supplementary Essay. Written in reply to Mr. F. H. Bradley's conclusions, in 'Appearance and Reality,' it is necessarily of a most technical character. But its suggestiveness will repay some effort. It will serve, also, as I believe, to render many more completely conscious of the change that the last fifty years have wrought upon the old ideals of definiteness and accuracy. These, indispensable desiderata as they are, possess certain limitations. Perception of these limitations has led some to reconsider conceptions once deemed fundamental without question. No doubt, as Mr. C. S. Peirce seems to indicate (SCIENCE, No. 272, pp. 430 ff.), Mr. Royce may be mistaken regarding some matters that lie specially within the purview of the mathematical expert. But, all the same, so far as I am capable of judging, no one can fail to be stimulated by his discussion, not merely of Bradley, but also of Cantor and Dedekind. If he were to have formulated no more than a forcible illustration of the intimate connection between mathematical and metaphysical problems, he would have earned our warm congratulations.

It need hardly be added that the book is one with which all workers in Professor Royce's own field will have to reckon.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

A Preliminary Report on the Geology of Louisiana. By GILBERT D. HARRIS and A. C. VEATCH. Baton Rouge. 1900. 8vo. Pp. 354. Pl. 62.

This report on the geology of Louisiana is the first annual report of Professor Harris and one of a series of annual State reports bearing on agriculture, geology, and the development of the State, which are issued under the auspices of the State Board of Agriculture, and distributed free on application. It covers the operations for the season of 1899, and in printing, illustration, etc., is very well gotten up, though, as in many State reports, there are rather more than a fair share of typographical errors. There is an excellent index which is a boon to be thankful for, though, curiously enough, there is nowhere any date of publication.

The contents are divided into three sections (I) an historical synopsis of previous geological work done in the State; (II) general geology; and (III) special reports by various authors, in this case including the geology of the salt mines of the Five Islands, reports on clays, on fossil plants and invertebrates and a popular article on fungi injurious to standing timber.

From the well-known energy and acquirements of the geologist in charge, ably assisted by Mr. Veatch, one naturally expects the clearing up of problems which have long puzzled geologists, with other positive additions to geological knowledge. And, since Professor Harris is a paleontologist and stratigrapher, we do not expect to see complicated questions settled off-hand on the physiographic aspect of a few gravel banks. Nor are these anticipations disappointed.

Earlier workers, especially Hilgard, have insisted on the presence of cretaceous rocks in Louisiana, but their distribution has been more or less uncertain and in the absence of skilled paleontological assistance Lower Eocene fossils have been sometimes taken for Cretaceous remains, etc. One important result of the current work has been the establishment of the fact that the upper Cretaceous (Ripley) under its blanket of Tertiary strata, extends, with a general parallelism to the old Eocene shore line, in many folds in a NE–SW direction. A fairly good list of Cretaceous fossils has been secured, though, as in the other strata of the State, the preservation of the fossils leaves much to be desired. It is to be regretted that the absurd pale yellows allotted by international agreement to the Tertiary, make it almost impossible to prepare an intelligible map of a Tertiary region in color. We should advise Professor Harris in future to use plain black and white symbols for this purpose.

The work on the Tertiary accomplished by this survey is most important, and would have been impossible for any one less versed in the lower Eocene paleontology than Professor Harris. He demonstrates the presence of the Midway horizon in Louisiana, for the first time, in two localities and further search will doubtless reveal others.

The Chickasawan (Mansfield of Hilgard's earlier work and one of the multitudinous 'Lignitics' of authors) is now found to cover a large area in Louisiana. Parts of it, through absence of expert paleontological knowledge, have been referred to the Vicksburg, Jackson, Claiborne and other subdivisions of the Eocene, in earlier work. Now we have its boundaries approximately defined and a well illustrated faunal list of species provided. In future work we trust Professor Harris will discard entirely the obsolete and misleading name of Lignitic and adopt the geographical term for this stage which is accepted by the majority of geologists interested in this horizon.

Jacksonian strata extend, as the author shows, from the Oachita river to the Texas boundary, while the Oligocene beds of the Vicksburg horizon are confined to the region between the Oachita and Red rivers.

Considering the small appropriation available for the work, the State of Louisiana is to be congratulated on the amount and quality of that which has been accomplished. It is to be hoped that Professor Harris may be able to continue his labors, and that the perplexities presented by the Pleistocene deposits of the State may yield to persistent study in the future.

W. H. Dall.

The Physiological Rôle of Mineral Nutrients. By Dr. Oscar Loew. Bull. 18, U. S. Dept. of Agriculture. 1899.

Dr. Loew discusses the actual part of the various mineral substances in the physiology of the vegetable organism, a matter of prime importance to the agricultural experimenter, as well as the botanist. Every advance in this subject has been won by the most arduous labor, and only in a few instances may the conclusions reached be considered as final.

The treatment of such an unsettled subject within the limits of a bulletin must result in many omissions in order to bring points of the greatest interest prominently to the attention. By reason of such necessity one does not find the names of Wieglieb, Marcgraf, Senebier, or Boussingault in the historical resumé of the subject, which otherwise traces the course of investigation on the subject somewhat clearly.

Phosphoric acid is necessary for the formation of the essential constituents of the nucleus and plastids, inclusive of the chloroplasts and chlorophyll; secondary potassium phosphates are found in combination with certain proteins; iron takes part in the formation of chlorophyll although it does not enter into the composition of the molecule of this substance, and is not to be considered of more importance in this connection than many other substances. Attempts to replace iron with manganese have met failure so far. Chorides are necessary for but few species; they are taken up in quantity by aquatics and other plants however.

The presence of potassium salts seems necessary for the synthesis and translocation of carbohydrates and proteins. This element may be replaced by rubidium or caesium in certain fungi.

The relation of calcium salts to the translocation of carbohydrates is not clearly defined, but this substance is abundant in all parts of the bodies of the higher forms of plants. It is notable that many of the simpler organisms may exist and attain full development without this element, and Dr. Loew advances the theory that the development of the higher plants both in form and differentiation of function becomes possible only when the capacity to assimilate calcium and use the resulting calcium proteid compounds is acquired; a theory which is based chiefly on coincidence.

Magnesium is found in nuclear substances and is abundant in embryonic tissues; its exact rôle cannot be defined. The relation of the element sodium to the organism is most problematical; it may exert a stimulating effect upon protoplasm, or its presence in the substratum may facilitate beneficial chemical changes. It does not enter into the composition of the plant in appreciable quantity however. The bulletin does not give adequate treatment to the pure mechanical functions of salts in the maintenance of turgidity, and it might have gained in value to the agricultural experimenter by the delineation of lines of practical investigation to be followed. It is highly controversial in parts and one is impressed with the very great differences of conclusions which may be reached from a consideration of the same facts by a comparison with the sections of Pfeffer's Plant Physiology or any other publication treating the same subject.

D. T. MACDOUGAL.

Science Sketches: Chemistry its Evolution and Achievements. By FERDINAND G. WIECHMANN, PhD. New York, William R. Jenkins. 1899. Pp. vii + 176.

The study of the evolution of chemical science from its earliest beginnings possesses a fascinating interest. The author of this little book has endeavored so to present the subject as to make it useful to all who take a general interest in science. In matters which pertain to the development of chemistry before the nineteenth century the treatment is satisfactory. For the present century the book does not altogether succeed in tracing the *evolution* of the science. It seems rather to give a series of more or less isolated facts about the growth of chemical knowledge than to give a clear picture of the development of the science. Perhaps this should not be too severely criticised, for it is immensely difficult to give such a picture for the period in question.

If the theory that diamonds are extra-terrestrial in origin has actually been proposed by any one as suggested on p. 117, it must have arisen from a curious confusion as to Moissan's thought in the matter. Moissan says that in discovering the diamonds in the meteorites he has 'caught nature in the act,' meaning, not that the diamonds were in the meteorites as they flew through space, but that they were formed during the passage of the meteorite through the air and its subsequent cooling. This thought seems to have guided Moissan in his successful production of diamonds.

In the discussion of liquid air the failure to mention the pioneers Cailletet and Pictet is remarkable. Some reference should also have been made to the Linde machines by which liquid air is now produced in quantity on essentially the same principle as that used by Tripler.

W. A. NOYES.

BOOKS RECEIVED.

Scientific Papers. PETER GUTHRIE TAIT. Cambridge, The University Press. 1900. Vol. II. Pp. 500.

Railroad Construction, Theory and Practice. WALTER LORING WEBB. New York, John Wiley & Sons; London, Chapman & Hull, Ltd. 1900. Pp. x + 456.

Introduction to Science. ALEXANDER HILL. London, J. M. Dent & Co. Pp. 140.

SCIENTIFIC JOURNALS AND ARTICLES.

THE April number (Vol. I., No. 2) of the *Transactions* of the American Mathematical Society contains the following articles: 'On the metric geometry of the plane n-line,' by F. Morley; 'On relative motion,' by Alexander S. Chessin; 'Plane cubics and irrational covariant cubics,' by Henry S. White; 'A purely geometric representation of all points in the projective plane,' by Julian Lowell Coolidge; 'The decomposition of the general collineation of space into three skew reflections,' by Edwin B. Wilson; 'A new method of determining the differential parameters and invariants of quadratic differential quantics,' by Heinrich Maschke; 'On the extension of Delaunay's method in the lunar theory to the general problem of planetary motion,' by G. W. Hill; 'On the types of linear partial differential equations of the second order in three independent variables which are unaltered by the transformations of a continuous group,' by J. E. Campbell.

THE May number of the *Bulletin* of the American Mathematical Society contains the following articles: 'On the geometry of the circle,' by Dr. Virgil Snyder; 'Isomorphism between certain systems of simple linear groups,' by Professor L. E. Dickson; 'The Hessian of the cubic surface,' by Dr. J. I. Hutchinson; 'Note on the group of isomorphisms,' by Dr. G. A. Miller; a review by Professor F. S. Woods of two memoirs by Lobachevsky, translated from the Russian by Engel; a review by Professor James Pierpont of Vogt's Leçons sur la resolution algébrique des equations; a review by Professor L. E. Dickson of Young and Linebarger's Elements of the Differential and Integral Calculus; a review by Mr. J. K. Whittemore, of Pascal's Calculus of Variations; 'Notes'; and 'New Publications.'

THE *Botanical Gazette* for April contains a new study of *Isoetes* by Dr. R. Wilson Smith, of the Hull Botanical Laboratory. It is concerned with the structure and development of the sporophylls and sporangia, and is illustrated by eight plates. The paper is a valuable contribution to our knowledge of the structure and relationships of a much vexed group. Dr. Roland Thaxter publishes concerning the structure and reproduction of *Compsopogon*, a peculiar group of filamentous blue-green algæ, andillustrated by a single plate. Dr. J. C. Arthur publishes the results of cultures of Uredineæ in 1899, giving eleven species whose aecidial and teleutosporic forms have been definitely connected. C. Sauvageau writes concerning the origin of the thallus, alternation of generations, and the phylogeny of *Cutleria*. The number also contains the usual installment of book reviews, notes for students, and items of botanical news.

THE *News Bulletin*, Number 4, of the New York Zoological Society, contains several fine pictures of animals now in the Society's park, as well as two showing methods of installation. The most striking of these is the Alligator Pool in the reptile house which with its background of palms has a pleasing suggestion of the tropics about it; the pool proper is 35 feet long, 9 feet wide and 4 feet deep, giving ample space for its occupants. It is noted that the largest alligator has added four inches to the length of twelve feet and one inch which it possessed when brought from Indian River in July, 1899. This seems rather a rapid rate of growth for so large an alligator. The water birds are reported to be passing successfully through their spring moult and we look to the park for some tangible evidence for or against the vexed question of color change in feathers without moult. In the bird house the experiment has been tried of decorating the walls which form the backs of the cases with landscapes and this has been done so successfully by Mr. Robert Blum that the cranes have several times tried to walk through the wall. A call is made for new members as funds are needed for various improvements and for immediate expenses, and it is to be hoped that the admirable showing already made may cause this call to be listened to.

THE leading article in *The American Naturalist* for April is by George James Peirce, on 'The Relation of Fungus and Alga in Lichens,' and the author considers that the association is one of parasitism of the former upon the latter. Howard Crawley describes 'A Flagellated Heliozoan,' which he considers a form of *Vampyrella lateritia*, and H. S. Jennings presents a paper on 'Reactions of Infusoria to Chemicals: a Criticism' of a paper by W. E. Garrey. L. B. Walton discusses 'The Basal Segments of the Hexapod Leg,' attempting to homologize and account for the origin of these parts, and R. W. Shufeldt has some 'Notes on the Psychology of Fishes.' Frank C. Baker describes 'A New Museum Tablet' of binders' board, edged with black and faced with manilla paper, and T. D. A. Cockerell treats at some length the question of 'The Lower and Middle Sonoran Zones in Arizona and New Mexico,' in which he shows that in the arid west the influence of fluctuations of temperature is much greater upon cultivated than upon wild plants, these latter having become adapted to their environment. Under 'Synopses of North American Invertebrates' Harriet Richardson gives a second part of The Isopoda. The reviews are almost entirely confined to those of zoological literature.

The Plant World for April opens with a paper by Mary G. Fanning, on 'Some Algæ in Ornamental Waters.' Sadie F. Price notes 'Abnormal Leaves and Flowers,' E. W. Berry 'Abnormal Forms of Dogwood,' Willard N. Clute has a fifth article on 'The Making of a Herbarium,' and Mrs. Caroline A. Creevey concludes the series devoted to 'Plant Juices and their Commercial Values' with a brief paper on dye plants. C. F. Saunders notices 'The Small Mistletoe in Pennsylvania,' and the editor comments on forest preservation. Charles Louis Pollard, in the supplement presenting the 'Families of Flowering Plants,' treats of the order Glumifloræ—the grasses and sedges.

SOCIETIES AND ACADEMIES.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 323d regular meeting was held on Saturday, April 5th. C. H. Townsend spoke of 'The Flying Foxes of the South Pacific Islands' under this title describing the fruit bats, *Pteropus*, found during the recent voyage of the United States Fish Commission steamer *Albatross*, and illustrating his remarks with lantern slides and specimens. The speaker stated that no bats were found in Polynesia to the eastward of the Tonga and Samoa groups although search was made for them.

A large rookery of flying foxes on the island of Tongatatu was visited and many fine photographs were taken showing the bats clinging in large numbers to the tree-tops. The rookery is located in a small native settlement near Nukalofa, the bats about 8000 in number, occupying the tops of 14 large trees in the midst of the village. The rookery is carefully protected by the chief of the village, who permitted the naturalist to take away only three specimens. It was understood that they had been guarded by the people from time immemorial, although the animals are frugivorous and evidences of their depredations on the island fruits were found constantly.

Mr. Townsend collected many flying foxes at Namuka Island (Tonga group), where they were found scattered in the forest. They were seen in the Fiji and Samoan islands also but no specimens were secured.

In a paper entitled, 'Acorns as Food,' Mr. V. K. Chesnut, after briefly mentioning the various places where sweet acorns are, or were, used for human food along the Mediterranean and in the United States and Mexico, gave a special illustrated account of the interesting manufacturing and chemical processes which have gradually been evolved by the Indians of Mendocino County, California, to extract the tannin and the bitter principle from the bitter acorns. The acorns of the black oak (*Quercus californica*), chestnut oak (*Q. densiflora*), and valley white oak (*Q. lobata*), especially, constitute an important and almost essential portion of the food of these Indians during the greater part of the year.

Mr. W. A. Orton spoke on the 'Sap-flow of the Maple' in spring, giving a brief description of the methods of making maple sugar and a report of some of the investigations made at the Vermont Experiment Station under the direction of Professor L. R. Jones. Sap pressure and flow in the sugar-maple occurs at intervals from October to May, when the weather conditions are favorable, but is most active for a month during March or April. To produce sap-flow it is necessary that the temperature should rise from several degrees below the freezing-point to some degrees above it. If this change be at all sudden there will be developed a pressure within the tree of 15–25 or more lbs. per square inch. Charts showing the relation of the temperatures as measured by a self-recording thermometer, to the sap-pressure recorded by a self-recording steam-pressure gauge attached to a maple tree were exhibited, and it was shown that in general there was a very close relation between sudden rises of temperature and of sap-pressure, there being pressure on warm days followed by suction at night. Sap flow diminished toward the top of the tree. It was greatest in the outer part of the tree, but continued longer from deeper in the wood. It was concluded that the cause of sap-flow was physical rather than physiological, being due to the expansion of confined air and water in the vessels of the wood, brought about by a sudden rise of temperature. There is little if any root-pressure during the season of sap-flow, and as the trees are dormant the old question of ascent of water from roots to leaves hardly enters into the problem. The direction of sap-flow was studied by injecting lithium into the tree near the tap-hole and testing the sap with a spectroscope. It was found that sap moves freely both up and down toward the tap-hole *with* the grain of the wood, but very little or not at all *across* the grain.

Other problems mentioned are still under investigation. F. A. Lucas.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF GEOLOGY AND MINERALOGY.

The meeting on April 16, 1900, was held at 12 West 31st Street, Dr. A. A. Julien presiding and 29 persons present.

Professor Stevenson, in behalf of the committee appointed to prepare a minute respecting the late Professor Hubbard, presented an obituary notice which is published on page 742 above.

Dr. R. Ellsworth Call presented 'Some Preliminary Notes on Crystal Growths in Mammoth Cave.' He first gave a brief resumé of the geology of the vicinity of Mammoth Cave. The strata making the geologic section are nearly horizontal and all the rocks forming the cavern are of sub-carboniferous age. The region of the cavern is capped with sandstones of the Chester Group 500 feet thick, beneath which are oölitic and other limestones, in which the cavern is excavated to a thickness of over 350 feet. The drainage level of the cavern is determined by the present level of Green River. Five different levels have existed during geologic time. No gypsiferous strata are known in the region. The overlying sandstone is usually quite ferruginous; but no pyrite occurs in either strata. Secondary crystallization has occurred in many of the stalactites causing them to simulate the fibrous appearance sometimes assumed by aragonite. The stalactites of recent origin almost all have a downward-projecting tree root as their origin of fixation, or are beneath sink-holes. The chief objects of mineralogical interest are the gypsum crystals which cover the sides and ceilings of certain avenues in the cavern, in the upper of the five levels only, and not in any levels now occupied by streams. These crystals are sometimes curiously and remarkably contorted and the terminations of the crystal masses are often recurved in a direction contrary to the direction of gravitation. Occasionally the gypsum assumes a botryoidal form, but is commonly found as needles or aggregated in loose masses of fibrous crystals. The gypsum crystals occur only along cracks, and are built up by increase from the base, while the calcium-carbonate stalactites are always built up by additions to their surface or terminations. It is difficult to account for the large amount of sulphur needed by assuming its origin in organic bodies, such as plants and the forests which are now of abundant growth in the region and have been so for geologic ages. The origin of the carbon dioxide necessary for the great work of solution which has been accomplished is likewise found in the decaying vegetation. The origin of the sulphuric acid required to produce these enormous quantities of gypsum crystals, which have fallen so abundantly as to fill up certain avenues, is still problematic. Only one other mineral is found, flocculent crystals of magnesium sulphate, pendant from the ceiling of two or three small rooms. There are no calcite or quartz crystals. The paper was illustrated by lantern slides showing the peculiarities of the stalactite and gypsum formations.

Professor Kemp, in discussion, suggested that the small percentage of sulphur present in the limestones themselves might, after solution of the latter, aggregate sufficient sulphur to afford gypsum along the crevices. Doctor Julien and Professor Stevenson each cited cases in the Caribbean and Bermuda Islands where the amount of vegetation now or formerly growing on the surface was insufficient to accomplish the solution required for the great caves which exist in the coral limestones, both of tertiary and recent growth in the islands.

A paper by Doctor E. O. Hovey, on the 'Scenery of the Harney Park District in the Black Hills, South Dakota' (illustrated with lantern slides), was read by Professor Kemp, owing to the former's unavoidable absence. After a brief resumé of the geology of the Black Hills district, a series of views was shown illustrative of the extraordinary erosion forms of the schists and pegmatites of the Harney Peak district. The photographs also showed the tin mines of the Black Hills, in which spodumene crystals of large size have recently been obtained as a valuable source of Lithium, as a commercial product. One spodumene crystal here obtained was thirty feet long. The granite veins have also been described by Van Hise.

Discussion followed on occurrences of extraordinarily large crystals of other minerals.

THEODORE G. WHITE,
Secretary of Section.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis, on the evening of April 16th, Mr. Herbert F. Roberts, of the Henry Shaw School of Botany, addressed the Academy on 'The Structure and Physiology of the Cell in the Plant Organism.' The history and development of cytology as a special field in biology were traced, and the origin of the various theories of cell organization was indicated. The development of various theories respecting the centrosome and its rôle in cell division was discussed, the homologues of the centrosome to be found in ciliated cells and spermatozoa being indicated. After a review of the processes of cell division and their attendant phenomena, the methods of study of mitoses in plants and their proper illustration were considered. A great need exists for more accurate processes of reproduction than is afforded by plates made from camera lucida drawings. The latter are always more or less diagrammatic, and are apt to be modified by the personal bias of the investigator. Unconsciously the personal equation enters in. This is seen in recent work on the subject of the existence of the centrosome in higher plants. The difficulty referred to can be overcome by the employment of photomicrography. This has been made use of to a limited extent by zoologists in the study of mitoses, but apparently scarcely at all by botanists. The speaker showed some forty prints from photomicrographic negatives showing mitoses in rhizomes of *Erythronium albidum* and in microspore mother cells, and microspores in *Lilium philadelphicum* and *Pinus laricio* and megaspores in *Lilium Canadense.* The possibility which photomicrography affords, of giving structural details with relative fidelity, was illustrated by these photographs and by lantern slides.

Eight persons were elected active members of the Academy.

WILLIAM TRELEASE,
Recording Secretary.

AMERICAN MATHEMATICAL SOCIETY.

A REGULAR meeting of the Society was held at Columbia University on Saturday, April 28, 1900. As has grown to be the custom, a portion of the day was set apart for a joint meeting with the American Physical Society, at which papers noted below were read by Professors E. W. Brown and R. S. Woodward. President Woodward occupied the chair, yielding it during the joint session to Professor Hallock, of the Physical Society. The amendments to the constitution outlined in the report of the February meeting were adopted. The following persons were admitted to membership: Professor R. D. Ford, St. Lawrence University, Canton, N. Y.; Dr. L. W. Reid, Princeton University, Princeton, N. J. Eight applications for membership were received.

The following papers were presented at this meeting:

(1) DR. VIRGIL SNYDER: 'On some invariant scrolls in collineations which leave a group of five points invariant.'

(2) MR. A. S. GALE: 'Note on four theorems of Chasles.'

(3) PROFESSOR CHARLOTTE ANGAS SCOTT: 'A theorem on quadrilaterals in space.'

(4) MR. F. H. LOUD: 'Sundry theorems concerning n lines in a plane.'

(5) DR. E. J. WILCZYNSKI: 'Transformation of systems of linear differential equations.'

(6) PROFESSOR FLORIAN CAJORI: 'Semi-convergent and divergent series whose product is absolutely convergent.'

(7) PROFESSOR E. W. BROWN: 'A possible explanation of the eleven year period of sunspot activity.'

(8) PROFESSOR R. S. WOODWARD: 'An elementary method of integrating certain linear differential equations.'

(9) DR. G. A. MILLER: 'On a certain class of abelian groups.'

(10) PROFESSOR H. B. NEWSON: 'On singular transformation and continuous groups.'

(11) PROFESSOR E. O. LOVETT: 'Group theory and geometry of four dimensions.'

(12) PROFESSOR E. O. LOVETT: 'The condition that a linear total differential equation be integrable.'

(13) PROFESSOR C. H. HINTON: 'Observations on the principle of duality.'

After the meeting several members of the Mathematical and the Physical Societies dined and passed the evening agreeably together.

The summer meeting of the Society will be held at Columbia University, June 27th–30th in connection with the meeting of the American Association. F. N. Cole, *Secretary*.

Columbia University.

NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The regular monthly meeting of the New York Section of the American Chemical Society was held on Friday evening, April 6th, at the Chemists' Club, 108 West Fifty-fifth street. Dr. C. F. McKenna presided, and the following papers were read;

'A Method of Obtaining Nucleic Acid,' by Dr. P. A. Levene.

'Analysis of a Saline Deposit from Southern Nevada,' by Ralph W. Bailey.

'Notes on the Ferrocyanide Titration of Zinc,' by Dr. E. H. Miller and E. J. Hall.

Special announcement was made of an extra meeting to be held on May 2d, for the exhibition of novel forms of apparatus, products, etc., and that the meeting would be in the nature of a reception, to which the ladies and friends of the members would be invited. The Section on this occasion will be the guest of the Chemists' Club.

An invitation to attend the next meeting of the New York Section of the Society of Chemical Industry, to hear a paper on 'Petroleum and its Products,' by Dr. C. F. Newberry, signed by Dr. Parker, was then read, after which the meeting adjourned.

Durand Woodman,
Secretary.

DISCUSSION AND CORRESPONDENCE.

PHYSICAL OBSERVATIONS DURING THE TOTAL SOLAR ECLIPSE.

To the Editor of Science: While the most important observations during the total eclipse of the sun are, of course, astronomical, some simple physical observations can be made with little or no apparatus and may serve to elucidate two obscure atmospheric phenomena, namely, the so-called 'shadow-bands' and the changes in the direction and velocity of the wind.

Professor R. W. Wood, in Science of April 27, has described the appearance of the shadow-bands and has given instructions for observing them, so that, although I myself had prepared a circular of instructions for co-operating observers, yet, in consequence of the fact that so able a physicist as Professor Wood will study this phenomenon, I shall be glad to send him my own observations and any that I may receive. It may be interesting here to state briefly the results of the observations made and collected by Professor Winslow Upton, Mr. A. E. Douglass and myself during total solar eclipses. In the eclipse of August 19, 1887, observed in Russia, it was cloudy and no shadow-bands were seen, but in the eclipse of January 1, 1889, observed in California with a clear sky, the bands were well defined, though an attempt to photograph them failed. They were more prominent at high altitudes than at low levels, but they seem to have no connection with the position of the stations in or near the shadow-belt. While the reports of the various observers indicated a general agreement for the direction in which the bands lay, yet there was no uniformity in the direction of progression which seemed not to be related to the direction of the wind. In every case the speed of the bands was much less than that of the shadow itself, thus disproving the theory that the bands are diffraction fringes in the shadow of the moon. The observations are discussed by Professor Upton and myself in Vol. XXIX., No. 1, *Annals Astron. Observatory of Harvard College*. During the eclipse of April 16, 1893, observed in Chile under the most favorable circumstances, the shadow-bands were very generally seen immediately after totality. They lay approximately northwest and southeast, and moved mostly towards the southwest at a speed variously estimated at from three to twenty miles an hour. The width of the bands appeared to vary from one-eighth of an inch to four inches, and their distance apart from one to ten inches. A significant fact was that, contrary to the observations in the previous eclipse, the bands were much less conspicuous on the mountain summit, occupied by the writer, than near sea-level, where they were also coarser, thus indicating the effect of increased thickness of atmosphere.

The many reports which were collected about the 'eclipse-wind,' so-called by the late Mr. Ranyard (*Memoirs Roy. Astr. Soc.*, Vol. XLI., Chap. XXXV.), show that some change in the direction and velocity of the wind usually occurs. Theoretically, the passage of the moon's shadow, by suddenly chilling the atmosphere, ought to increase the barometric pressure along its path and so cause an outflow of air in all directions. Investigations to determine the amount of this change of pressure were made by Professor Upton and the writer during the eclipses previously mentioned with the result that the changes which could be attributed to the eclipses were found to be too small to measure directly, even with most sensitive barometers. But a very slight gradient suffices to deflect the wind or to alter its velocity and this effect was detected by us (see *Amer. Meteorological Journal*, Vol. IV., and *Annals Harvard Observatory*, previously cited). At a station traversed by the shadow there should be a deflection of the wind contrary to clock-hands before totality and a movement in the opposite direction after the shadow has passed, if the wind blows from the northern side of the eclipse track, or *vice versa* if the wind blows from the southern side. A wind having the same general direction as the shadow should be accelerated when the shadow advances and retarded when it recedes, and a wind blowing into the advancing shadow should be diminished before this arrives and increased afterwards. During totality a lull in the wind might be expected, analogous to the calm experienced in the center of an anti-cyclone.

Although some of these effects have been perceived, observations in various parts of the shadow-belt are desired in order to confirm or disprove the theory. Therefore, I shall be glad to receive any information about the changes of the wind near the surface of the ground and high up in the atmosphere during the coming eclipse. To determine the direction and strength of the surface-wind a light streamer, or pennant, attached to a freely exposed pole, may be observed several times just before and just after totality, while, if high clouds are visible, a single observation of their drift before and after totality will give the direction of the upper wind with sufficient accuracy. A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL OBSERVATORY, HYDE PARK, MASS.

THE UNIVERSITY OF CINCINNATI.

TO THE EDITOR OF SCIENCE: In my statement regarding the situation at the University of Cincinnati, as published in your issue of April 27th, the omission of four words, in a short paragraph on page 669, results in an erroneous statement.

The sentence should read: "During the greater part of the twenty-five years which have elapsed since the organization of the university, the institution has been without a president." THOMAS FRENCH, JR.

'00 OR 1900.

THE use of the *year of publication* in its full or in its abbreviated form is coming into very general use as a 'catch title' in bibliographic lists and citations. The abbreviated form, *e. g.*, '97, for 1897, cannot be used for more than one century without ambiguity. There are two possibilities concerning the usage of the abbreviation '00; it may stand for either 1900 or for 1800. It is desirable that usuage should be uniform. Since the use of the abbreviated form began in the present century,—about 1880, if I am not mistaken,—the omitted figures have always been 18. It seems to me that that is reason enough why we should use '00 always to mean 1800, not 1900, even though the current year belongs to the twentieth century. Thus the apostrophe would without exception stand for the same omitted figures, 18. E. L. MARK.

HARVARD UNIVERSITY, April 20, 1900.

CURRENT NOTES ON PHYSIOGRAPHY.

THE MEXICAN BOUNDARY.

THE 'Report of the Boundary Commission upon the survey and re-marking of the boundary between the United States and Mexico, west of the Rio Grande, 1891–1896' (Washington, 1899) includes a chapter devoted to a general description of the country adjacent to the international boundary line, of which the most notable features, in addition to the marked aridity of the climate and to the great scarcity of perennial streams, are the "bare, jagged mountains rising out of the plains, 'like islands from the sea,' the abundance of the evidences of volcanic action in times geologically recent, the parallelism of the mountain ranges with one another and with the Pacific coast, the general absence of trees, the preponderance of evergreen vegetation, with its dull, leaden-green hue, the prevalance of thorns in nearly all vegetation, the general absence of fragrance in flowers, * * * and the abundance and large size of the cactus." The trail across the Yuma desert passes numerous graves or monuments to travelers who lost their lives from thirst. Besides the volume of text, with 49 plates, there is an atlas containing an index map, 19 detailed maps on scale of 1 : 60,000 with sketched contours, and five plates of profiles, and an album of 258 excellent plates reproduced from photographs of the boundary monuments, and showing, incidentally, an unequalled series of landscapes of that desert region.

GLACIATION OF SIERRA COSTA, CALIFORNIA.

THE 'Ancient Alpine glaciers of the Sierra Costa mountains in [northwest] California,' are described by O. H. Hershey (*Journ. Geol.*, vii, 1900, 42–77). The peaks reach 7000 to 9000 feet. Non-glaciated valleys are V-shaped, hardly wider at the bottom than their streams, and with ragged spurs projecting from their sides. Where the walls are of serpentine, land slips have occurred, forming hummocky, moraine-like masses in the valley bottom. If followed up to their glaciated stretches, they become open U-shaped, with smooth slopes, free from lateral ravines and spurs. Above the smoothed glacial channels, the mountain slopes are still ragged, deeply scored with ravines. Lateral moraines are well developed; terminal moraines are less distinct. The heads of the main and branch glaciated valleys are cliff-walled corries, often holding small rock-basin lakes. Meadows of bog and grass occupy portions of the upper valley floors, as if replacing shallow lakes. Further down, the trunk valley floors are often broken by precipitous steps from one to five hundred feet high.

A curious case of stream diversion by glacial action is described. The upper part of the valley of Coffee creek (descending northeastward) had in preglacial time a higher floor than the neighboring upper part of the next valley on the west, that of South fork of Salmon river (descending northward), the two being separated by a low dividing ridge. The glacier of Coffee creek obstructed its own valley by a moraine several hundred feet thick, and at the same time ran over a sag in the low lateral divide and descended westward into the adjacent deeper valley, wearing down a gorge through the sag. Hence the present head of the South fork of Salmon river rises in the head of the former Coffee creek valley, follows it for five miles to the valley-floor moraine, within a few hundred yards of the present head of Coffee creek, then turns west through a narrow and rapidly descending cleft and thus deserts the Trinity for the Klamath river system.

THE TROUGH OF LAKE NYASSA.

THE suggestion made by Thomson in 1882 that Lake Nyassa in southeast Africa lies in a down-vaulted trough or *Graben* is confirmed by Bornhardt (*Verhandl. Gesellsch. f. Erdk.*, Berlin, xxvi, 1899, 437–452). The lake surface is 500 meters above sea-level; its bottom sinks several hundred meters below sea level. On either side are highlands from 1000 to 2000 meters in altitude. Fault breccias occur along the border of the trough. The highlands on the northeast where traversed by Bornhardt, consist in part of gneiss and granite. At a moderate distance back from the rapid descent to the lake, the highland surface presents gentle undulations with broad and shallow valleys of gentle fall, while the border of the highland for 10 or 15 kil. back from the trough is trenched by torrential streams in deep valleys of rapid fall, and the rolling surface is there transformed into a series of ragged ridges, scored by steep ravines. Here erosion is in its youthful stage; on the broader highland surface erosion has reached a stage of repose (*Ruhestand*) at the close of a long undisturbed period. The activity of the young streams in the highland border indicates a geologically recent date for the production of the trough.

W. M. DAVIS.

THE MAKING OF A MUSEUM.

Mr. L. P. GRATACAP has reprinted, as a separate, his article on Museums which originally appeared in the pages of the *Architectural Record*, and the pamphlet makes an acceptable contribution to museum literature. Many of the points in the making of a museum from the general style of the building to small details of installation are well and concisely treated and frequent diagrams help to a better understanding of the text. On most points the reader will find himself in substantial accord with Mr. Gratacap, but some of the dicta must be regarded as expressions of individual opinion rather than of a general agreement on the points at issue. The personal equation will more or less unconsciously influence the opinions of any one writing on the subject of museums and what would meet with the unqualified approval of an ornithologist might not please an invertebrate paleontologist. If any apology is needed for noting that there are differences of opinion concerning the correctness of some of Mr. Gratacap's views it is to be found in the fact that the growing interest in museums, the large sums of money involved in their construction and maintenance, and the great value, in every sense of the word, of their collections seem to demand a careful consideration of all details of construction and installation.

Light is a question of vital importance to a museum, but Mr. Gratacap tells us nothing of the various methods of electric lighting that have been devised especially for museums and nothing of the Luxfer prismatic glass for throwing light into dark corners. And while the lighting of the building as a whole is considered at some length, the question of the window glass is not touched upon. As a matter of individual opinion the windows of a museum should be of ground glass, unless prismatic glass is required for special places, not only to exclude the direct rays of the sun and thus lessen injury to the specimens, but to diffuse the light; any arrangement of curtains that will keep out the sun will deaden the light also. The alcove system of arrangement is discussed and the statement made that by this method table cases are excluded. What has always seemed an ideal arrangement, and one that was shown to good advantage in the exhibit of the U. S. National Museum at Chicago, and may now be seen in portions of the Field Columbian Museum, is the alcove system with table cases in the center of the alcove ; if there is any better plan than this, where there is sufficient overhead light, the writer has yet to see it.

Passing to the cases themselves it may be said that the objection to case doors pushing upwards is not that the glass can not be cleaned, an objection that is purely imaginary, but that it is difficult to make such a case dust tight, a difficulty that may be largely overcome by careful construction ; on the other hand the size of the glass that may be used in a counterpoised sash, and the ease of handling may be looked upon as offsetting many disadvantages. It is to be doubted if a case can be built with sashes sliding by one another that will be either dust proof or attractive in appearance. For floor cases the double desk case with upright center, sometimes termed a Liverpool case, is most admirable for the display of minerals, shells, or other invertebrates.

Any disposition of shelves must necessarily be adapted to suit the specimens, but it is frequently, if not usually, found in practice that it is decidedly best to have the broadest shelf near the center of the case and a little below the level of the eye. To place the broadest shelf near the bottom of the case prevents the use of the floor for large and bulky objects. As for glass shelves they are often very desirable since they do transmit a great deal of light while not presenting the heavy appearance that is unavoidable where wood is used. While talking of shelves the omission of any mention of the Jenks brackets is a little strange as these are for many purposes much better than any others.

The best methods of exhibiting fossils may as yet be undiscovered, but some excellent beginnings have been made both in the American Museum of Natural History and in the U. S. National Museum, and among these beginnings many consider the use of encaustic, not terracotta, tiles which Mr. Gratacap looks upon with doubt. The color and texture of these tiles are agreeable to the eye, their first cost is small, their color is uniform and they do not fade by exposure to light; also specimens which have been cemented on may be removed by soaking, the tile cleaned and used again. The arrangement of invertebrate fossils mounted on these tiles in almost vertical series enables the collection to be seen at a glance and to be read with the facility of a printed page.

Above all things it should be borne in mind that no hard and fast rules can be laid down for the display of specimens, but that methods must be modified to suit the subject. The main effort of an exhibition series must be to attract, interest and instruct the public and for this purpose a small number of carefully chosen specimens, well installed and well labelled is to be preferred to a multiplicity of objects which fatigue the eye and by their very number prohibit careful examination. The student will always search for information. One great aim of a museum should be to impart knowledge to the visitor who is not looking for it.

F. A. L.

SCIENTIFIC NOTES AND NEWS.

McGill University has conferred its LL.D. on Professor Geo. F. Barker, of the University of Pennsylvania, on Captain Alfred T. Mahon, U. S. N., and on Mr. J. F. Whiteaves, of the Canadian Geological Survey.

The Paris Academy of Sciences has elected Professor van der Waals a corresponding member in the place of Sir George Stokes who was recently made a foreign member.

Dr. W. J. Holland, the director of the Carnegie Museum of Pittsburg, has been requested by the trustees of the Carnegie Institute to devote his entire time to the management of the growing departments of that institution. Director Holland is now the chancellor of the Western University of Pennsylvania and the Carnegie trustees are anxious that he should relinquish that position in order to devote his time to the administrative and scientific work of the Institute.

The tenth award of the Riberi prize of 20,000 lire ($4000) will be made by the Royal Academy of Medicine of Turin, on December 31, 1901, for the best printed or manuscript work, or the most important discovery, during the five years, 1897–1901, in experimental pathology, hygiene, or forensic medicine.

The Danish Academy of Sciences has elected to foreign memberships Professors E. van Beneden, of Liège; W. Fleming of Kiel; H. Dohrn, of Naples; Th. Engelmann, of Berlin; R. Helmert, of Potsdam; L. Henry, of Lyons; M. Treub, of Buitenzorg, and H. de Vries, of Amsterdam.

Mr. Alfred L. Kroeber, fellow of Columbia University, has been appointed curator of anthropology in the Museum of the Academy of Sciences of California at San Francisco.

Mr. R. H. Yapp has been appointed assistant curator of the Herbarium at Cambridge University.

Sir J. Barry Tuke, known for his studies in mental disease, is a candidate for the vacancy in the parliamentary representation of the Universities of Edinburgh and St. Andrews, caused by the death of Sir William Priestley.

Professor A. A. Michelson of the University of Chicago, has been appointed commander of the First Ship's Crew, Illinois Naval Militia. He is a graduate of Annapolis and served in the navy for several years.

Dr. James M. Safford, for many years professor of biology in Vanderbilt University and State geologist of Tennessee, will retire from active work at the close of the present session. Dr. Safford has done a great deal of field work throughout the State of Tennessee, and is also known as the writer of important scientific articles and a valuable work on the geology of Tennessee.

Professor Kitasato of Tokyo, has discovered a second bacillus which he considers to be an etiological factor in the production of plague. He has also produced a new plague serum.

Professor Jacob E. Reighard, of the department of zoology in the University of Michigan has established a camp on the Huron River near Geddes and is engaged in studying the habits of the dog fish (*Amia Calva*) in its natural surroundings. These are of special interest owing to the fact that after the eggs have been laid the male guards them and the young fish.

The Council of the British Institution of Civil Engineers has made the following awards for papers read and discussed before the Institution during the past session: A George Stephenson Medal and a Telford Premium to Sir Lowthian Bell, LL.D., F.R.S.; Telford Medals and Premiums to Mr. H. Dalrymple-Hay, Mr. B. M. Jenkin, Mr. F. W. Bidder, and Mr. F. D. Fox; a Watt Medal and a Telford Premium to Mr. J. Dewrance; a Crampton Prize to Sir Charles Hartley; and Telford Premiums to Mr. C. N. Russell and Mr. R. A. Tatton.

THE executors of estate of the late A. B. Bolton, of Chicago, have presented to the University of Illinois his entomological collection, which is said to be one of the most complete private collections in the world. It is valued at $50,000.

THE death is announced, at the age of 73 years, of Mr. George Highfield Morton, author of publications on the geology of Lancaster and North Wales. He was awarded the Lyell medal of the British Geological Society in 1892.

THE London *Times* calls attention to the fact that M. Alphonse Milne-Edwards, whose death we were compelled to record last week, was the grandson of Mr. Bryan Edwards, M.P., the West India planter and historian, who settled at Bruges, and son of Henri Milne-Edwards, the eminent zoologist, who died in 1885. He was born in Paris in 1835, graduated in medicine in 1859, became professor at the School of Pharmacy in 1865, and in 1876 acted as his father's deputy as professor of zoology at the Jardin des Plantes. He was the colleague of Edmond Perrier in the deep-sea explorations of the *Travailleur* and *Talisman*, and was awarded the gold medal of the Geographical Society. In 1877 he succeeded M. Gervais in the Academy of Sciences, and in 1885 entered the Academy of Medicine. In 1891 he was appointed Professor of Zoology and Director of the Jardin des Plantes, and occupied a house there. His death is a great loss to that institution and to science. Among his numerous scientific works may be mentioned: 'Recherches anatomiques et paléontologiques pour servir à l'histoire des oiseaux fossiles de la France' (1866–1872), 'Recherches sur la faune ornithologique éteinte des Iles Mascareignes et de Madagascar' (1866–1874), 'Éléments de l'histoire naturelle des animaux' (1881–1882), 'Expéditions scientifiques du travailleur et du talisman pendant les années 1881, 1882, et 1888,' and the papers on mammals and birds in Grandidier's 'Histoire physique naturelle et politique de Madagascar.'

AN expedition to northern Labrador will take place this summer under the leadership of Professor E. B. Delabarre, of Brown University. It will sail from St. Johns, Newfoundland, about June 24th, and return toward the middle of September. Its aim is the exploration of the coast and interior as thoroughly as the time will allow. One or two scientific men might yet find a place on this expedition; an expert geologist would be particularly welcome. Application should be made at once to Professor Delabarre, 9 Arlington avenue, Providence, R. I.

MISS JOSEPHINE E. TILDEN and Miss Caroline Crosby, of the University of Minnesota, with Mrs. Henry Tilden, of Minneapolis, sailed from Vancouver, May 4th, for Honolulu and the islands of the South Pacific, for the purpose of collecting marine and freshwater algæ.

THE steamship *Windward* has been docked at St. Johns, Newfoundland, and will be thoroughly repaired. It will proceed thence to New York and afterwards to the Arctic regions.

A TELEGRAM has been received at the Harvard College Observatory from its Arequipa Station stating that the position of Eros on April 26, 21 h., 22 m., Greenwich Mean Time, was 15 minutes of arc preceding and 8 minutes south of the position given in the ephemeris by Daniel N. Jones, Jr., published in *Popular Astronomy* (January, 1900), p. 41. This appears to be in response to a letter which was sent to Arequipa on March 12th, asking Dr. Stewart to photograph Eros with the Bruce Telescope, and determine the correction to the above ephemeris.

THE Lick Observatory expedition to observe the total solar eclipse of May 28th, is located a short distance northwest of Thomaston, Ga. Thomaston is a village of about 1800 inhabitants, some 60 miles south of Atlanta. The observers from the Lick Observatory are astronomer W. W. Campbell and assistant astronomer C. D. Perrine. After the instruments are mounted and adjusted, these observers will be joined and assisted by Professor A. A. Nijland, director of the Utrecht Observatory, Dr. J. H. Wilterdink, astronomer in the Leiden Observatory, and by about twelve professional and amateur astronomers from various parts of this country.

The Western University of Pennsylvania will have an expedition in the field to observe the total eclipse of the sun, which occurs at the end of this month. The expedition will consist of Professor F. L. O. Wadsworth, the director of the Allegheny Observatory; Professor S. M. Kintner, of the Engineering School; Dr. J. A. Brashear, the noted instrument maker of Pittsburgh, and others. Dr. Holland, the Chancellor of the University, may be of the party.

Professor Ormond Stone, director of the Leander McCormick Observatory, of the University of Virginia, will occupy a station for the observation of the eclipse, at Winsboro', S. C. His special aim will be to obtain means for studying characteristics of the filamentary structure of the inner corona, which was carefully observed by him, near Denver, during the total eclipse of July 29, 1878. The observations will be both photographical and visual. Dr. William J. Humphreys, of the same university, will occupy a station near the edge of the shadow, in order to study the 'reversing layer.'

The Russian Government has established a station at Villa Franca, near Nice, for deep-sea explorations. A special yacht for the station has been constructed in Zurich.

The Botanical Section of the American Association for the Advancement of Science, The Linnean Fern Chapter and The Sullivant Moss Chapter will be the guests of the New York Botanical Garden on Wednesday, June 27th. By invitation the Torrey Botanical Club will present a memorial program in honor of Dr. John Torrey in the lecture hall of the Museum, beginning at 10 a. m. The following features of this program have already been determined: 'Historical Sketch of Botany in New York City,' by Dr. T. F. Allen; 'Personal Reminiscences of Dr. Torrey,' by Professor T. C. Porter; 'Work of Dr. Torrey as a Botanist, with Bibliography,' by Dr. N. L. Britton; exhibition of letters, pictures and material illustrative of Dr. Torrey's work, by Mrs. Elizabeth G. Britton and Miss Anna Murray Vail; work of the Torrey Botanical Club, by the Secretary, Professor Edward S. Burgess. A large amount of interesting historical material has already been sent in response to the inquiry of the Secretary of the Section.

A summer school of natural history has been established by professors of Beloit College on Madeline Island, Lake Superior. Courses in physiography are offered by Professor G. L. Collie; in geology by Professor Grant Smith, and in botany by Professor H. B. Densmore. The location of the school is very favorable for the study of these sciences. The courses will open on July 27th and will continue until August 30th, and the fee for tuition and materials, including the use of a microscope, is only five dollars.

The international conference for the protection of wild animals in Africa, was opened at the British Foreign Office on April 24th, and was attended by plenipotentiaries of France, Germany, Great Britain, Congo Independent States, Italy, Portugal and Spain. A plan is advocated for the establishment of large reserves like Yellowstone Park, where wild animals may live under natural conditions.

The need of protecting the larger wild animals is illustrated by a 'Note on the Word Bison,' in the *Bulletin* of the American Museum of Natural History, where Dr. J. A. Allen states that the American bison is practically exterminated in the wild state and its perpetuation depends upon the care and skill exercised to preserve the domesticated herds which, it is estimated, comprise between 300 and 500 individuals. There are possibly 20 bison in the Yellowstone National Park and not a dozen outside of it. About 50 of the Wood bison, the variety found in the vicinity of Great Slave Lake, are believed to be in existence. The paltry numbers given above are all that are left of the millions that once roamed over the west and northwest.

The American Medical Association will hold its annual meeting this year in Atlantic City, New Jersey, on June 5th, 6th, 7th and 8th.

The Third International Ornithological Congress will be held at Paris from June 26th to June 30th, as one of the series of meetings to be held in connection with the Paris Exposition. The President of the Congress is Dr. E. Oustalet; the Secretary-Treasurer, M. J. de Claybrooke, and Dr. Alphonse Milne-Edwards who has just died was the Honorary President. The members of the Congress will be the delegates from the French and foreign governments and those who may become members by the payment of a subscription of 20 francs, while zoological and similar societies may be represented by delegates. There are to be five sections as follows: 1. Systematic ornithology, anatomy, paleontology. 2. Geographic distribution, migration. 3. Biology, nidification, oology. 4. Economic ornithology, bird protection, aviculture, acclimatization. 5. Organization of the permanent international ornithological committee. The following is the provisional program under the various sections:

1. Systematic ornithology; classification; descriptions of new genera and species, nomenclature. Anatomy and embryology of birds. Paleontology; classification, descriptions of new genera and species, ancient faunas, relation of extinct to living species.

2. Geographical distribution of birds; existing faunas, species extinct within historic times. Migration. Accidental occurrence of exotic species.

3. Biology; habits, food, nidification, oology.

4. Economic ornithology; protection of useful species, destruction of injurious species, hunting. Acclimatization. Aviculture.

5. Organization and duties of the international ornithological committee. Election of new members.

The International Anti-Tuberculosis Congress, attended by more than 1000 delegates, was opened in the San Carlo Theatre, Naples, on April 25th, in the presence of King Humbert, Queen Margherita, the Prince and Princess of Naples, and the Duke of Genoa. The delegates present represented the Governments of Germany, Austria-Hungary, France, Spain, Portugal, Sweden and Norway, Greece, Roumania, Russia, and the United States, and included the Duke of Ratibor and Professor Virchow, from Germany, and Dr. Lannelongue from France. The first sitting of the congress was devoted to a discussion of the prophylaxis of tuberculosis.

The Anatomical Society at Pavia held its annual meeting this year at Pavia from April 18th to the 21st, under the presidency of Professor Gustav Retzius of Stockholm. Among those who contributed papers were Professors Waldeyer, His, von Kölliker, Giacomini, and other well-known anatomists.

The following announcement has been made by the British Foreign Office: The Secretary of State for Foreign Affairs has received a despatch from Sir H. MacDonell, her Majesty's Minister at Lisbon, containing the following information regarding the facilities which will be granted by the Portuguese government to foreign astronomers visiting Portugal in May next for the purpose of viewing the total eclipse of the sun. A communication has been made to the Lisbon press, stating that, on the occasion of the eclipse of the sun in May, when a number of foreign astronomers are expected to visit Portugal, owing to its favorable geographical position for observation, customs facilities will be granted for the admission of scientific instruments, books, etc., which such visitors may desire to bring with them. Astronomers from abroad will be exempt from payment of the usual custom duties on production at the custom-house, on arrival of a certificate drawn up by the astronomical society to which they may belong, setting forth their names, and describing the instruments and books which are to be imported. This certificate, however, should be legalized by the nearest Portuguese Consulate before starting. Further, it is announced that the Ministry of War has informed the Ministry of Education that all the military authorities of the districts of Vizen, Aveira, Guarda, Castello Branco, and Coimbra will afford any possible assistance to astronomers during the observations, and that tents will be lent to observers, on a request being addressed to the Ministry of War in Lisbon to that effect. A Government notice has now been published in the *Official Gazette*, stating that the King has nominated a Royal Commission for the purpose of assisting in every way those who may come from abroad for scientific observations, and for superintending arrangements generally. This commission will sit either at the Royal Observatory, Lisbon, or at the Society of Geography, Lisbon; its president is his Excellency Señor Marianno de Carvalho.

UNIVERSITY AND EDUCATIONAL NEWS.

The Ohio Legislature with only three dissenting votes has placed a special tax on property for two years of one-twentieth of a mill on the taxable property of the State for the Ohio State University. This will yield $90,000 a year, which will provide a building for the department of physics and one for the college of law.

It is reported in the daily papers that the Rev. F. H. James of Oakley, Kans., having inherited a large sum of money, will endow a Methodist University in Kansas City with $1,000,000. It is also stated that he has also given $300,000 for a college in Oakley. It is to be hoped that these reports are correct.

The University of Wales has received a bequest of £5500 for the foundation of scholarships from the late Mr. Price Davies.

The summer school in practical mining of Columbia University will be conducted by Professor Robert Peele at Cripple Creek, Colo. After five weeks spent in the mines the student will have two weeks work in geology with Professor Arthur Hollick.

Nature states that the report of the Advisory Committee appointed to inquire into the best manner for providing for scientific and commercial training respectively in connection with the new University of Birmingham has just been issued. It will be remembered that Mr. Andrew Carnegie and an anonymous donor each promised a gift of 50,000*l.* toward the establishment of these two departments. The committee have made inquiries as to facilities for the teaching of science in its application to industries, and they report that, in their opinion, no such teaching, complete as they contemplate it, and as it must be, if it is to be successful, exists in any college in Great Britain. In making their recommendations, the committee have had in view the object of the teaching of science in its application to industry, coupled with such technical instruction in handicrafts as will enable the students to complete their course in the University itself. It is proposed that the facilities already provided in Mason University College should be supplemented by chairs of mining, metallurgy, engineering, and applied chemistry. The scheme submitted contemplates the introduction of a complete equipment for the treatment of metals by heat and a small plant for treatment by electricity, as well as the necessary outfit for testing metals. Shops would be provided for manual training, and it is recommended that the machines used should be of the best and most modern type of English, American, and foreign manufacture. The committee further recommend the acquisition of 25 acres of land in the outskirts of Birmingham on which to build the University, their estimate of the total cost being 155,000*l.*

Professor C. S. Prosser has been made acting head of the Department of Geology in Ohio State University.

The following fellows have been appointed at the University of Pennsylvania: Zoology, J. R. Murlin and Miss R. A. Vivian; pedagogy, I. B. McNeal; mathematics, U. S. Hanna; biology, Miss C. B. Thompson; sociology, Miss C. Kimball.

Professor Ludwig Boltzmann, of Vienna, has accepted the call to the chair of physics in the University of Leipzig.

M. Moissan has been appointed professor of inorganic chemistry in the Paris School of Pharmacology in the place of M. Riche who has retired.

Mr. J. F. Hudson, of Oxford University, has been appointed mathematical lecturer at University College, Bristol, in succession to Mr. J. F. McKean who has been appointed a mathematical lecturer at the Royal Naval Engineering College, Devonport.

Dr. Meyer has qualified as docent in physics in the University of Vienna, and Dr. Oppenheim as docent in theoretical physics in the German University of Prague.

SCIENCE

FRIDAY, MAY 18, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor, J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE APPROACHNG TOTAL ECLIPSE OF THE SUN.

THE plans of some of the principal parties from American observatories for the observation of the total solar eclipse occurring on the morning of May 28th are as follows:

The arrangements by the United States Naval Observatory have been made under the direction of Professor S. J. Brown, the Astronomical Director, and contemplate the occupation of three stations, two on the central line, and one near the northern limit of totality.

The first station on the central line is under the immediate supervision of Professor A. N. Skinner, and is located at Pinehurst, N. C. The party will comprise, in addition to the five members of the Observatory staff, associate members engaged in spectroscopic and other researches. These include Professor Ames of the Johns Hopkins University, and Doctors Dorsey, Huff and Reese, and other assistants from the physical laboratory of the University. In the photographic work Dr. F. L. Chase, of Yale University, and Mr. A. L. Colton, of the University of Michigan, will take an important part. The work at the station will comprise the establishment of the latitude and longitude, visual and telescopic observations and drawings of the corona ; photographs of the corona with the 40-foot photoheliograph lens, the $7\frac{3}{4}$-inch visual lens belonging to the Naval Academy equatorial 114-inch focal length, two 6-inch Dallmeyer lenses of 40-inch focus, one of them provided with a color screen and a special Voigtlander lens of special construction of 4-inches aperture and 8-inches focal length, also provided with a color screen. The spectroscopic work, under the direction of Professor Ames, will embrace observations of the reversing layer and corona with a concave grating of 10-foot radius and rulings 6x3.5 inches, 15,000 to the inch, and a plane grating with rulings of the same dimensions used in connection with a quartz objective of 3.5 inches aperture and 60 inches focal length. A prismatic camera with a very transparent prism of 6 inches length and 5.5 inches on the face, and an object-glass of 4 inches aperture and 6 inches focal length, will also be used at this station by some of the observatory force, as yet unassigned. Dr. Dorsey will make observations on the polarization of the corona with an apparatus designed by himself, while Professor E. R. Wood, of the University of Wisconsin, in co-operation with other observers along the eclipse line, with an instrument designed by himself, will measure the velocity, distance apart and direction of the shadow bands.

The second station on the central line will be at Barnesville, Ga., under the immediate supervision of Professor M. Updegraff, assisted by five of the regular staff of the observatory. The operations at this station will be similar to those at the last in regard to latitude and longitude, and the observations of the corona visually and with the telescope. The photographic work will embrace photographs of the corona with the 40-foot photoheliograph lens, a 6-inch visual lens of 96 inches focus provided with a color screen, and a 6-inch Brashear photographic telescope of 80 inches focus under the charge of Mr. C. A. Post of New York, to whom the instrument belongs. Additional photographs on smaller scale will be taken with a 6-inch Dallmeyer, 33 inches focus, a 4-inch Dallmeyer, 17 inches focus, and a 3.5-inch Dallmeyer, 9.5 inches focus, provided with a color screen. The only spectroscopic work at this station will be photographs of the reversing layer and the corona with a slitless spectroscope, under the charge of Professor H. C. Lord of Columbus, Ohio, by whom it was designed and constructed.

The station at the northern limit near Griffin, Ga., will be for the study of the reversing layer and the corona, and will embrace observations with powerful gratings both flat and concave. Professor Crew and Dr. Tatnall of the Northwestern University will observe with a concave grating of 10-feet radius; Professor Humphreys of the University of Virginia, assisted by Mr. Dinwiddie of the same institution, will observe with a concave grating of 21.5 feet radius; while the grating objective will be used by Mr. L. E. Jewell of the Johns Hopkins University and Dr. Mitchell of Columbia University, New York. This instrument is identical to the one in use at Pinehurst. The two flat gratings and the concave grating at Pinehurst have peculiar and unusual qualities for the special line of investigation for which they will be used. The size of the ruled space on these gratings, and the peculiarities of the ruling, which throws all the light into the first order spectrum, gives a brilliancy to the spectrum which could not be attained by any practicable combination of prisms.

It happens that a large number of parties will congregate at Wadesboro, N. C., a situation which the weather observations for the past three years rather surprisingly singled out as likely to be favorable in its meteorological conditions. It is nevertheless unfortunate that these parties are not more widely scattered along the path of totality, so that fickle weather conditions should not affect all alike.

We have already described the plans of several of the parties at Wadesboro. They include one sent out by the British Astronomical Association, which successfully observed the recent eclipse in India; a group of observers from Princeton; a party from the Smithsonian Institution; several astronomers from the Yerkes Observatory of the University of Chicago, and a party from Vassar College. A great variety of observations will be undertaken by these large parties, the most novel of them being that of measuring the heat radiation of the corona during the ninety seconds of totality, by very delicate bolometers, which will be attempted by some of the members of the Smithsonian and the Yerkes observatory parties. Elaborate spectroscopic investigations will also be made, if the weather permits.

The Lick Observatory sends to Thomaston, Georgia, the well equipped expedition already described in this JOURNAL which plans extensive spectroscopic and photographic observations. Another California party, from the Chabot Observatory, will make numerous photographic exposures at Union Point, Georgia.

The party from Harvard College Observatory at Greenville, Alabama, will make a determined campaign with powerful appliances for the purpose of discovering an intra-Mercurial planet.

The Allegheny Observatory will send a party to Fort Deposit, Alabama, equipped with extensive photographic and spectroscopic apparatus as described in a recent issue.

Expeditions from the U. S. Weather Bureau and the Blue Hill Observatory will conduct appropriate observations at Newberry, S. C., and Washington, Ga., respectively.

With favorable weather conditions we may reasonably expect a considerable increase in our knowledge of the problems of the solar surroundings, which can be only studied during the brief interval of total solar eclipses.

THE PRINCIPLES OF SCIOSOPHY.

"The physical world is the world of illusions. The non-physical is the world of realities in matter."—*Aber.*

"The cell is an illusion: it is merely a word: thus it is with the body, so it is with the earth and with the solar system."—*Judge.*

A RED letter day in the annals of the Astral Camera Club of Alcalde was Saturday, April 1, 1900. On this auspicious occasion was delivered the fifth annual memorial address before this organization, and in this address, for the first time in the history of human thought, were clearly set forth the principles of the divine cosmic science of Sciosophy.

But science I should not say, nor yet philosophy. It is not wholly either, but greater than either. Child of both and parent of both, as the heavens surround and include the earth, so does Sciosophy surround and include all else within the thought of humanity. Sciosophy, in the words of the venerable sage of Angels, is that "ocean of knowledge which spreads from shore to shore of the evolution of sentient beings, unfathomable in its deepest parts, though shallow enough at its shores." Though Sciosophy may be new, its elements are not. Nothing in the world of mind can be really new. The 'stones of Venice' were stones of course, before Venice rose from the sea. They waited the builder whose magic touch should transform rock into palace, who from the marble quarry should draw forth St. Marks. Thus Sciosophy has waited its hundred centuries for the living touch of Abner Dean. Its basal ideas, the Greeks held, the Hindus and the Arabs, while the restful teachers of all climes have foreseen their wondrous possibilities. Under the wand of the prophet behold as an exhalation of fragrant incense rise the astral verities of Sciosophy!

It was indeed a fortunate inspiration, (though I say it who should not) which came to the Secretary of the Astral club. The fifth anniversary of its foundation should be laid deep and broad and on it should be emblazoned its deathless principles. And these great truths at once astral and abysmal, deeper than the ocean and higher than the stars, who so fitting to set them forth as this great prophet of the western pines in whom the Orient has found at last its Occidental reincarnation?

This memorial address of Mr. Abner Dean, will be printed *in extenso* in the due fullness of the seasons. But in advance of the proceedings of the Astral Club, it is proper that this brief summary—however inadequate, should reach the waiting public—

"In boyhood's rosy dawn" began Mr. Dean, "I lived in Kennebunkport, Maine, and as I wandered over hill and dale, by forest and sea, my mind was occupied by questions of what may be and what might be in the universe, what its limitations really are, and whether indeed these limitations exist.

"My parents, practical Yankee folk that they were, said that I was dreaming, and doubtless they were right, for through my dreams I learned that the dream is the sole reality. It is one of the great world-principles that whatever I think becomes real with my thought. Thought is reality and the material stuff the vulgar call 'the real thing' is to the enlightened mind less than the 'baseless fabric of a dream.'

"For example," continued the sage of Angels, "I used to ask myself what I would do were there no law of gravitation? What if it worked in some way unknown to Newton's concept? What if I could myself alter it that it might serve my will? Then things would be very different from what they now are, or appear to be. So in my thought I made them different. How high I leaped in those days? How I gathered apples from the tallest trees? How I played shuttlecock with the stars, and carved my name on the silver-sided moon? For I understood as a child and contented myself with childish things.

"Then I turned to other supposed material facts or laws. What if friction were suspended, how I could slide over the curved surface of the horizon? What joy to hold the laws of combustion in my hand! What wealth could I turn one metal into another, or both into the primitive mind-earth-stuff or protyl from which all men and all metals and all dreams are made. O for the touch of gold, the bottomless mine of silver, the genius at whose astral enchantment all dreams come true! What if the stars could tell me their secrets, all that they have looked upon and all that has looked on them?

"As my mind grew more subtle I asked: What if the straight line be not the shortest distance between two points? What if 'the longest way around' be really 'the shortest way home'? What if space have other dimensions than length, breadth and thickness? As these three enclose matter, may they not need other three to enclose mind? Here I stumbled on the truth of the Astral body and the Shadow Phantom, as in other speculations I had touched on Alchemy and Astrology. And with all these I had wandered into the field of the celestial geometry, the mathematics that has no limit and as yet no name, the measurement not of land and lumber but of the astral spheres.

"Since those days I have wandered far from the shores of Maine, through scenes shifting and stirring, till in my old age I have come to rest under the singing pines. But through all these days my real life has lain in these problems and these questionings. When I laid down my pick and shovel on the banks of the green Stanislaus, I came to the true meaning of reality. Out of my boyish guessings as to what I would do were things that we know other than what they seem, or were things we know not clear before our eyes, arose at last the majestic cosmoid of Sciosophy. As material science works with microscope and scalpel or with pick and plow, so must spiritual science work with the finer tools of astral thought in its analysis and synthesis of the fundamental entities of creation. And these tools and methods do not soil the hands or materialize the soul.

"Speaking of Speculative Philosophy (which is an inchoate branch of Sciosophy) a distinguished adept of Boston has wisely noted its superiority over the 'gutter-psychology' so largely affected to-day. For as he says, such study brings no contact of the soul with vulgar matter. It 'does not soil the hands' nor blunt the sensibilities, and its reflex effect on the mind is purely one of etherization. For this reason he especially commends the study of Speculative Philosophy to thoughtful people of leisure and especially to cultured women. And surely the whole face of science and philosophy will be changed when it falls into the fair hands of the leisurely etherealized 'Eternal Womanly.'

"It will be seen that the study of Sciosophy is at once the complement, the opposite and the antidote of the study of material science. Its first principle is this, *Matter rests on Mind.* On mind it is dependent for its recognition which is its existence. Its laws are mental channels merely, the grooves into which the thought sustaining it most naturally falls. With your own mind you can cut such grooves, can make such laws; therefore do it! This will exercise your highest powers, the powers we call astral or star-born, because in all the visible Universe nothing can rise higher than the stars and nothing works so persistently as they in their quiet astral fashion.

"Would you change the law of gravitation? Then change it! You have but to assert yourself. If you have the courage to try, it is nothing to remove mountains, as men once did of old, as men still do who live upon the greatest mountains that there are. To remove their astral phantoms is the first work of the mind. When these are gone the material mountains crumble away into shapeless granite sand.

"But you may fail when first you try your eternal powers. Doubtless we are all feeble on the astral plane. We have lived on the material plane so long, with our eating of beef and our scramble for gold that the divine Karma has grown weak within us. We know not the powers we hold and we dare not put them to the test. So we buy our tickets on railway trains rather than flutter the pinions of the soul. We yield to the domination of matter and force when we should bring matter and force as humbled servants to our feet. We search far and wide for the useful and we miss that which is above all use, perfection carnate, incarnate and re-incarnate, the astral Karmal aura of the soul!"

After portraying in such fashion the value of effort which has its beginning, direction and end within the circle of volition, and after showing that the Karmal powers should be spent on the imponderable astral body, not on the dull muscles designed only as its refuge and shield, Mr. Dean returned to the basal principles of Sciosophy. These are, stated categorically as follows:

"1. Truth exists only in terms of human experience. 'The thing we long for that we are.' This accords with Lessing's Dictum. 'It is not the Truth but the search for Truth for which Man searches.' In other words Absolute Truth exists only in the Absolute expression of the Universal Mind.

"2. Whatever is true to me must somehow come into my thought; I must think it else it is not true. This accords with the great axiom of Descartes—'I think, therefore I am.'

"3. Conversely, what I think is true, which is therefore true to me is part of the Universal Truth. This follows from the discovery of Bishop Berkeley, that one thing is as real as another if as clearly apprehended, and its application to all things brings the Universe within the transcendent domain of Sciosophy.

"Through all the ages, men have striven to carry thought into action. All thought which cannot be thus treated, men have scorned as unpractical. They cannot use it in their business, therefore they will have none of it. But a higher aim is to carry action into thought, to bathe sensation in cognition, to dissolve low actuality in the Nirvana of the higher possibility.

"To this end man should believe all things, the impulse from within as well as the impact from without. No dream is too fair, no speculation too bold, no hypothesis too hazardous, no sensation too weird for the wise man's acceptance. The more occult beliefs he has, the greater foundation for higher astral credence. The courage of acceptance is the glory of Sciosophy.

"In all this one danger first arises. Beware of all Authority, whatever its name or nature. Whether it comes with the sacred sanction of religion or with the strident tongue of material science do you ever reject its claims. Trust no assertion, no convention, no tradition, no investigation. Whether it be the council of Nice or the Royal Society it is the same to you. What men have agreed upon has lost its occult value. Its efflorescence has perished in the dust of compromise. Only heresy is truth. The conventions of man, whether of priest, scientist or clodhopper, hamper the soul alike. Shun Science, shun Orthodoxy, shun Wealth. These be the trio of deceivers who have stolen the birthright of man. These be the sisterhood of delusions who linger cloud-like between humanity and the Karmal light of the ever-toiling stars.

"The evil of Orthodoxy whether of religion or science lies not in its beliefs but in its methods. It subordinates the soul to objective, collective beliefs to which it arrogates the name of Truth. Its teachings, indeed, for the most part, are consistent with Sciosophy. The evil lies in its fetters. The orthodoxy which does not bind you may be indeed precious. The orthodoxy of Ceylon or Baluchistan you may accept without reproach. If you do not understand its principles as its followers interpret them so much the better for your acceptance. From its occult meanings, you have a wealth of new ideas in store. The Hindu Orthodoxy will be as rich to you as the principles of Westminster to the convert Hindu Sciosophist.

"New ideas only can be made true. Only the will created the world out of nothingness. Only volition enters at the gate of Nirvana. What men have asserted, that is dead. The schools, the churches, the laboratories all deal alike with the dead. With the dead there is no reincarnation into Life's fruitage.

"To untrammeled transcendentalists, wherever banded together, we must look for the red vintage of the future. These be the brave souls who scorn matter and matter's laws, who rise above matter's method. These be the Mahatmas of our sceptic age, the reincarnation, in Psychic Society, in Karmal Club, in Astral Association and Atmal Initiates, of the Djinns and Giaours of the past. In their hands time and space will lie at last like facile wax, and the tales of Odin and Minerva, of Thor and Jupiter, of Gautama and Manitou, all that we modern weaklings, belated eagles who have lost our wings in the human barnyard, have called Mythology, it shall be theirs to recall.

"'There were giants in those days,' it is said. There shall be giants again. Not in bodily size perhaps, for the body of Goliath was a cumbersome shield of a dwarfed personality, but giants in power, demi-gods and archangels whose lightest thought shall shame all Science's boasted action.

"And right here in Alcalde, green crescent of the sun-kissed hills, now at the end of the longest, darkest, noisiest and most helpless of all the centuries of time shall the lost life begin again, the lost mysteries of the human priesthood be recovered, the lost aureole of man's youth become the glory of humanity's ripened age!"

This gracious remark led Mr. Dean to extol the pastoral beauties of Alcalde, which of all our towns most resembles in its setting the clustering deodars of Kapelvastu in the Hindu-Oudh, where Gautama was born.

This comparison was suggested, no doubt, by a remark of the secretary (though I say it who should not), who likened his own fair hamlet on the Stanislaus to an abode of Mahatmas on some velvet green meadow, above a Himmalayan gorge, rich with hidden treasures of thought and gold, while above both alike rose 'the great silent wonder of the snows.'

But he soon turned to other matters and closed his eloquent address with a classification of the lines of thought which radiate from Sciosophy.

Taking the strange science of Quaternions as an illustration Mr. Dean demonstrated its basal assumption that in astral space a straight line is the longest distance between two given points. All other lines are consequently shorter and from this discovery, mathematics divides into two sciences, and the new science brings into the world a vast play of mental activity and a gigantic array of unsuspected truths.

"By the same method, we have only to assume that some part of the body material or astral is more sensitive than the visible eye or ear. From this discovery arises the vast science of Telepathy or more exactly Telepathology. The central fact of this science rests on the extension of the aura of the sensator across time and space to the astral eye or ear of the sensatee. By this process, all manner of suggestions may be transmitted, and these over any distance or through any time. It is as easy for example for me, as an adept, to speak to Marcus Brutus, through Telepathy, as for me to speak to the Lama of Thibet, and equally easy for Plato or Ptolemy to speak to me Through this power I may yet dissuade Brutus from his awful deed, or save Cæsar from that ambition through which fell emperors and angels. Knowing this, the whole significance or Sciosophy of history must be re-written. Nothing comes ever too late in time and the great tangled fabric of the past is ever open to reconstruction.

"To continue such investigations we may further assume that any supposed law of nature is something different from what it appears to be. *A definition creates a new science.* Thus if we transpose the law of heredity we give to the ancient wisdom of Reincarnation, and the transmigration of the astral ego, all the perpetuity which in scientific circles through like methods is ascribed to the 'Germ Plasm.' The vast range of phenomena commonly classed as 'Reverberations from the Monkey State,' or 'Echoes of the Fish Existence,' finds in reincarnation a simple explanation. Even past reincarnations are never fixed; all that is or was or shall be lies open to our volition. It is one of the great charms of Sciosophy that with each new dictum accepted, we have a new series of conciliations and explanations. And the perfection of each of these makes good the hypothesis with which we started and forms the basis for as many more.

"Reincarnation thus once established as a fact, it is easy by a little further hypothesis to trace the progress of individual souls in their flight through history, as well as the telepathic influences which other great souls born and unborn have upon them. Their victories and reverses are open to our eyes, and from these the laws of soul-growth each initiate may establish for himself.

"By the finest Sciosophic studies, the author of 'How Souls are Educated' has traced the ego of Alexander the Great from its first incarnation in the wilds of Crim Tartary, to 'the Jewish hermit adept called Jesus,' thence to Alexander, Alaric, Charlemagne, Edward the Black Prince, Henry VIII., a Cornish fisherman, an African king, a Staten Island carpenter, a Harvard senior, an explorer in the Persian Alps, his soul-ripening being finally complete as 'Old Mountain Phelps the hermit guide of the Adirondack Forest'; thirty incarnations in all from crudity to perfection.* 'But one more necessary experience,' it has been shown, 'awaits his soul—that of womanhood.'

"It is easy to demonstrate through these strange changes that up to a certain point souls develop as wild vegetation does by the action of laws external and internal and their own inherent instincts. Then as a gardener takes a wild-crab tree, prunes, cultivates, trains, nourishes, plants its seed in different soils, until he has a fine fruit good for human use, so the gods take a soul, train and prune it until it is fit to nourish by example and precept the souls of other men and to pass by our earth. The soul of Alexander the Great, on leaving the body of Henry VIII., passed under the immediate care of the gods, and the fourth phase of its existence began, the phase of purification, for as a fruit may rot because of too much sunshine, so may a soul, and all rot must be purged away.

* 'Education of Souls,' 1893, p. 17.

"Another ego, whose gyrations have been traced and placed on record, begins the soul life as a woman, the savage wife of a savage. She dies in the forest; reborn she dies in the slums; then in a convent; then at the stake, one of the martyred Waldenses; then a grand lady slain in a feudal castle. She is reborn as St. Elizabeth of Hungary and again as a great lady who is by no means a saint; next she is Milton's daughter, Dorothy; and to-day she is alive and within the United States, perhaps indeed the very reader of these pages undergoing the pangs of her final transformation.

"'The companion-soul of St. Elizabeth' says the gifted author above quoted, 'was the husband of her first two incarnations, in the latter of which she abandoned his children before his body was cold. In the third she did not meet his soul until after she had begun her infamous life. When they did meet, his efforts to save her were pathetic but unavailing. In the fourth he was her father, the gardener, and it was his love for her that drew her to his house, a better place than she deserved or could have entered but for his love. In the fifth he was the pastor of the church to which she belonged, and it was his teaching that gave her courage to die. In the sixth he was the baron, in the seventh the king, in the eight the lord to whose death she was a party and whose children she threw into the river. Thus far this soul, although it has had hundreds of incarnations and a wide range of experiences, has watched over the soul of St. Elizabeth and tried to help her in nine of her ten incarnations.'"

"The soul of William of Orange, it has been discovered, is 'now in the body of a boy 4 years old (in 1893) in the state of Connecticut,' while 'Richard, the Lion-hearted, is a little boot-black in New York City.'

"'Each world in the great belt has a soul and between the smallest moon and the greatest sun, these worlds vary as do the souls of men and may similarly become extinct through weakness and debasing passion.' 'The bodies of lost sun-souls are called comets.' 'The cry of a lost sun-soul,' the comet-shriek is 'the most terrible sound that ever rings through the great belt.'

"Through such studies as these a vast literature has arisen, but it is a mere drop in the bucket as compared with the possible. When men shall realize the basal principles on which these discoveries rest, the reincarnational and recessional history of each man and woman who has ever lived, with all its hidden meanings shall be given to the world. And by the same token, each man and each woman who has ever lived shall re-write the history in his own fashion, for in Sciosophy, the past, like the present, must depend solely on the point of view.

"Still another line of investigation is this. In those fields in which the material senses, teach us nothing, we may create facts and laws of our own volition.

"Thus Chamisso and D'Assier have given us the laws of the Spontaneous Activity of Shadows. Mr. William Q. Judge has shown us how the Astral Ego may 'overcome the natural illusions of Devachan,' and how Yuga Kalpa and Manvantara may complete the great Astral cycle of Avatars, reaching at last the exploding point at which is caused 'violent convulsions of the following classes: (a) Earthquakes, (b) Floods, (c) Fire, (d) Ice.' Through these methods the thought movements so scientifically demonstrated by Mr. Thomas Jay Hudson have been laid bare. Similarly etheric vibrations become words or things under the puissant hand of a Blavatzky, or the flowing tongue of a Besant. In this manner, the natural history of spooks, wraiths, and night-followers has become matter of fact, and the laws once established in thought must remain, for science has no power to controvert aught but ponderable masses of matter. It will be seen from this that all myths are true, while all records of human achievement contain the element of myth. This gives zest to the Higher Criticism whether applied to Homer, to Daniel, or to William Tell, and endlessly varied are the truths which may be drawn from it. In like manner to Egyptology, Anthropology and even to Philology, the same methods are daily applied and the more ancient the line of research, the broader the harvest of its modern aftermath. It is through a consistent application of the methods of Sciosophy that Lombroso discovered the marks or stigmata that distinguish the genius, the degenerate, and the fool. It was Sciosophy that made Hegel a philosopher, Beaconsfield a statesman, Flammarion an astronomer, and Wilberforce a saint. Sciosophy plays about the doctrine of Heredity and the Ghosts and Night-Followers (Gjengängere), of Ibsen, the spasmoids of Sarah Grand, the grotesques of Poe, have taken their place among astral realities. Our pathway is blocked by apparitions of lost sins, our wisdom balked by the frivolities of our forefathers. Or should we care to relieve the darkness of this picture, we may sweep all these obstacles away by the angel wing of the inherited virtues of our long vanished grandmothers. Or if we turn our attention from the broken lives of grown up folks, we may trace similar influences at work in the play of children. The child loves the swing's refreshing sweep, because ancestral children lay in the ape's treetop cradle. The child likes to sleep with the cat because the touch carries it back to the race's ancestral childhood when the maternal furry tail curled round the infant lullaby.

"Even the staid sciences which call themselves exact may be made to effervesce under the touch of Sciosophy. We may change the chemical elements. We may photograph thought. We may analyze the color of a sound. The painting of the invisible, and all the marvelous sequel of Röntgen's wondrous demonstration bear witness to this. To be sure, the shadow picturing of Röntgen rises not above the material plane but its suggestions have opened the gateway through which the universal aura is divulged. The correlation of forces has led the way to the discovery of the hidden meaning of elasticity and the conservation of forces shows that the elements we know are only latent oxygen.

"The societies for the study of flowers through the opera glass, of stars in mirrors, of the signals of inhabitants of Mars, all rest on a broad basis of Sciosophy. The gifted author of 'How to Study Birds Without Knowing Anything About Them,' has taught us the value of Sciosophy in matters of common observation.

"In the study of human politics Sciosophic hypothesis has disclosed wonderful vistas of the social future. Men's dreams of the 'City of the Sun' shall dreaming men make real. Toward this end the struggle of the social reformer must tend. The effort to abolish legislation, the effort to make legislation universal, to own everything in common, to own nothing in common, to own nothing at all, to destroy all nations, impartially, by repealing the charters of their existence, and to extend the power of our own nation so that all nations in the world may come under her domination, all these movements tend in the same direction, the recognition of the unreality of external things. Only through such recognition can universal peace and happiness come about. If a single mode of taxation, a single article of diet, or a special form of ballot, will bring this for you, then adopt it and strive for it and behold it is yours. In other words, the perfection of being is within us, and to reject all that seems to be while struggling for the unattainable is the sole price of social rest. When each man has the happiness of which he dreams, he will have all the happiness he deserves. To attain this lies with him and with him alone.

"Not less charming than social Sciosophy is Sciosophy applied to medicine. In general disease is due to dislocation or wandering of the Posthom Phantom or Astral Shadow. When this is at rest the currents of the body flow in peace. As to immediate causes of disease, there are many theories, and all are true so far as they go, but in Sciosophy all permanent remedies have found their justification. The old dictum that 'like cures like' is purely sciosophic in its orgin, as it can rest on no material induction whatever. The same is true of the theory that 'every part strengthens a part' and that 'heroism demands heroic remedies.' As the body is the fabric of the mind so through the mind the body must be reached. Through the Manas or mind alone can the dislocated Astrum or Linga-Sarira be adjusted to the Rupa or body, which it was made to fit. This readjustment depends on the will and the will has been jarred into action by many different influences. Contact with Kings or with bones or even with the garments that Kings or bones have touched or worn, has produced this result. Not that the aura of a King is more potent than that of a cab-driver, but that the impression of Royal Power is strong on the human mind, and the jolt that this impression gives may shock the shadow back to its place. A similar jolt is given by the modern necromancy of a popular cult in the art of healing. The nature of this action is clearly expressed in these words of the famous adept to whom the discovery of the secret of phantasmal dislocation was once vouchsafed. 'This cult' says the 'Mother' of the sect, 'demonstrates that the *patient who pays whatever* he *is able to pay for being healed* is *more apt to recover* than one *who withholds* a slight *equivalent for health.*' Hence this adept goes on to observe, her initiates are 'not indigent and their comfortable fortunes are acquired by healing mankind morally, physically and spiritually.'

"But right here is the greatest danger of all Sciosophy. Its precepts must never be sold for money. Once turn your dreams into coin, whether as novelist, poet, phrenologist, palmist, pulmist, horoscopist, astrologist or medicine-man, and all their sacredness disappears. The precepts of Sciosophy exist in endless store, boundless corollaries of unfettered hypothesis, but to convert them into gold is the Midas touch that works their degradation. To appeal to the principles of Sciosophy for hire is to become an empiricist, a quack, a leech, a vampire, to be everything that is lowest on the earthy chain, the lowest of all planes. It may be true, indeed, that he who pays most for his astral healing is likely to be soonest cured, but the pay degrades his astral healer. The adept who never touches earthy pay is the one most likely to be exceedingly rewarded, for the true reward is within himself.

"The Sciosophist who serves men for coin, does it at the sacrifice of his own soul. 'Before a soul can pass to life beyond our planet,' says a noted Mahatma, 'it must unroll the long coil of its incarnations and look itself in the face.' To have made a living by charting of skulls, or mapping finger tips on a basis of sciosophic inventions, to have cured diseases by faith or hope or the laying on of hands, to have cast horoscopes for money, or laid bare the secrets of the future through the light of moon or stars, tea-grounds or broken teacups, to have found gold or coal or water by witch hazel rods, rain through atmal incantations, or love through postage-stamp flirtation, all this is prostitution of a heaven-born gift. The soul of the sciosophist who has done such things dare not, when translated, look its past in the face. It must seek blindly a new incarnation, the lowlier the better, that it may start again free from temptations which assail the gifted and the great.

"The author of 'Body, Mind and Soul,' in a sciosophic trance, once saw in Devachan the soul of a famous adept, who, in his seventy-eighth incarnation, had 'acquired a gift of second sight and through it has acquired a comfortable fortune by healing mankind' in an elegant office in Chicago. His soul after physical death is thus described:

"A man six feet tall and fairly proportioned, who during life in the physical body claimed the friendship of a few of the world-famed great, when seen a few months after death had a tall frame. About a year later, he had arms and legs shrunken to about the size of a dog's legs; and the body shrunken, but still large, was carried on all fours; and the head had become of the shape one might imagine a cross between a dog and an alligator to produce; and the huge jaws were stretched in vain to make a sound of any sort. The soul of the man was encased in this hideous non-physical body, and readily recognized the writer. Two years later, this soul was seen near the fifth descent in the caverns; and the non-physical body which it had lately left was roaming about the first zone, a huge, lean, hungry alligator-dog, which preyed like a vampire on the vitality of any man to whom it could get access.

"It is easy to see from this that the sciosophic adept on his way to Nirvana gains nothing from a 'comfortable fortune,' wrung from the hopes and fears of men and paid for from the crystal aura of his own soul, the upper triad of Atma-Buddhi-Manas, the only thing in a changing world which is worth hoarding to you or to me.

"No, no, truth is within you, life is soul growth, wealth is wealth of the mind. Kamaloka, the place of desire, is not an elegant office in Chicago, or a Fifth Avenue home. Midway between heaven and earth it lies, and as your desires are so your future shall be. Whoso shall sell his dreams for lucre makes base coinage of his soul, and as I urge upon you the transcendent glories of Sciosophy, so do I warn you against Sciosophy's degenerate double, which is 'Humbug.' And as Sciosophy brings wealth above all vain imagining because it is Wealth of the Soul, so does Humbug bring soul poverty below all conception. You will know Sciosophy from Humbug by this mark and perhaps by this alone, that *Humbug pays*, and among all grades of Sciosophists as in all ranks and classes of men, Humbug has its Initiates, its Adepts and its Prophets!"

David Starr Jordan.

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*THE SOCIOLOGICAL STATUS OF THE PHYSICIAN.**

In preparing this address I have liked to think of it as a possible preface to chapters which other men, who love their work and to whom it is a profession of faith in a purpose of usefulness, and who are wiser and more apt than I, might write; for the relations of the physician to the social problems of his day and generation, while individual in their character and single in their purpose, are capable of manifold expression.

The term 'sociology,' first used by August Compte † less than sixty years ago, may be briefly and broadly defined as 'the science of the laws of human relationships' and, as often happens in the presence of cognate intellectual processes working toward the same end, the suggestion of a concise definitive appellation furnishes a rallying point to which the various workers converge and from which they go out, strengthened by a sense of companionship and encouraged to more extended effort by a better comparative knowledge.

The title sociology, therefore, beginning with an application in terms of positive philosophy, has come, in the short period of half a century, to include not only theories as to the organization of society, but practical considerations of the value, the application, the use, the control, and finally the prevention of certain social conditions.

The range of sociology, in its modern form, may be said to extend from investigation of the power value of psychic phenomena in the unit, to consideration of physical economics in the mass.

The original ideas of society as the product of extrinsic causes or of society as a force-aggregation upon a materialistic basis, have gradually given place to a recognition of the continuity of the ethical idea in an aggregation of human units, the majority of whom are relieved, in whole or in part, from the demands incident to a primitive struggle for existence.

It is precisely at this point in the development of sociology that a member of the body politic, who has long existed and who has indeed for several centuries had a definite sociological status, becomes an increasingly co-operative factor.

The science of society which has come in the growth of its responsibility to the human mass to find the need of a more accurate study of the entity of the human unit, turns to the doctor of medicine for advice and counsel.

To the members of the medical profession, whose devotion, primarily, to the needs of the unit, leads them to concentrate their energies upon a succession of individuals and who, consequently, find themselves isolated more or less from the social community and placed apart as specialized workers, the newer and broader sociology brings, not only the stimulus of association and sym-

* Delivered before the Congress of American Physicians and Surgeons, held at Washington, D. C., May 1, 2 and 3, 1900.

† Cours de Philosophie Positiv, 1842.

pathy, but larger opportunities for the exercise of their usefulness.

As a natural result of this approximation, appreciation grows, barriers of prejudice are broken down, the conventionalities of self in which pessimism is nurtured disappear, and men of different walks of life come to understand each other better, in the light of a common purpose to helpful ends.

The sociological status of the physician, therefore, at the present time, may be said to be his standing in regard to an extensive movement in behalf of the study of human relationships with a view to a truer comprehension of their normal bases and to the betterment of their existing conditions.

Before proceeding to a consideration of the effectiveness of the doctor of medicine as a part of the social organization exhibited through the medium of the institutions with which he is particularly related, and of the other duties of which he is capable and which lie before him, it will be well to consider briefly the character of his professional training and its reactionary effect upon himself as a man and a citizen.

Of all special educations that of the science and practice of medicine, when it is of the best quality, is the most exacting and makes the largest demand upon the staying power of the student; it is longer in duration, more confining, and requires more intense application than the corresponding courses which lead to a degree either in law or divinity, and affords a larger suggestive opportunity for collateral scientific reading.

It implies, in its beginning, the combating of natural repugnancies, and, in its continuance, a ceaseless struggle against the mentally depressing influence of daily contact with disease and dissolution, it challenges lofty sentiments and lays bare the framework of cherished emotions; on the other hand, it demonstrates truth and gives the foundation for a faith which, though usually silent and often circumscribed, nourishes the optimism necessary to this vocation, and helps the doctor to regard the affairs of life in the light of their importance, not to himself, but to the individual whom for the time being they most concern.

That the 'outward profession of faith' is not usual in the medical profession is due not to the lack of this quality, but rather to the reluctance to make public expression on the part of men whose life is, in its practical exhibition, largely confidential, and who, moreover, have especial opportunity to give utterance to the spirit within them in human contact work.

To the claim that medical education furnishes the material for a deep and lasting faith in a creating and sustaining power may be added the claim that it tends to beget that sense of reverence of which Benjamin Kidd says "that it is a preponderating element in the type of character which the evolutionary forces at work in human society are slowly developing, and with which are tending to be closely allied the qualities of great mental energy, revolutionary enterprise, powers of prolonged and concentrated application and a sense of simple-minded and single-minded devotion to conceptions of duty."

That attributes such as these may be nurtured in the stern curriculum of a medical education and fostered under the exacting conditions of a career which is both a practical application and the continuance of that education, we know; but it is also well for us to know, daily, that the possession of a most intimate knowledge of human life and its relationships implies an enormous moral responsibility.

In addition to the justly economic purpose of following a reputable vocation likely to ensure a livelihood, the principal incentive to the study of medicine is a purpose of usefulness, or a basal sense of a desire to express in some way the appreciation of an obligation, a purpose which is the underlying motive of all sociological effort.

Coupled with this is the desire for a more intimate knowledge of the purposes of living as expressed in terms of accomplishment.

In addition to these motives there is that which comes from the possession of a truly scientific spirit seeking the acquisition of knowledge and the establishment to mental vision, of a utilizable truth, with a view, not to any individual aggrandizement, but to the end of making this a stepping-stone for further progress; this sequence of stimulation usually carrying with it the sentiment that the work done is a contribution to the general welfare.

In the very beginning of his studies the medicalstudent is brought into investigatory relationship with that which he has heretofore thought of as an entity, a being, a mystery, and which, now put into his hands for demolition, he finds to be a most wonderful and delicately constructed machine, in the study of which he may be said to pass through much the same process of mental evolution as that attributed by Professor Giddings to primitive man. *

He is lost in marvel at the compact arrangement of muscular tissues, regards, as might the explorer of a buried city, the system of canals which carry quickening fluid to the outermost circumvallation and of drains into which are cast waste matters to be discharged without the walls; while the glistening white lines of nerves sending their branches in a network between muscles and under and over canals and drains, reveal to him the suggestion of a system for the communication of intelligence and the issuance of governing mandates to which the combined telegraphic and telephonic services of the greatest city built by human hands have no comparison in relative extent or in perfection.

* F. H. Giddings, 'The Principles of Sociology,' Anthropogenic Association, p. 246.

There is probably no point in his career of so much initial portent as that in which the student, in the dissecting-room, for the first time lifts the wet sheet from a face that he has never known, but behind which there dwelt, and through which there have been expressed, all that emotion and desire can crowd into the compass of a human life; it is a period in which he either consecrates himself or turns back; if he be honest he does one or the other; if he be a pretender he may, it is true, continue and complete his medical school course and go out into the broader school of work, but without the consecration he will inevitably fail of his highest possibilities as a physician.

The impress which is made by the study of anatomy upon the truly thoughtful man cannot but be emphasized in the physiological laboratory, where the student learns the values and uses of the different parts of the human machine and finds the answers to questions which the previous study of the structure of the silent body have evoked.

Here and in the associated laboratories he learns the chemical processes of the body in health and disease, the supplementary relationship of the different organs, the provision for their maintenance and repair, and comes to recognize and to know the functions of the microscopic organisms with which the body teems.

Carrying with him the lessons born of research, he next passes into the wider school of clinical teaching, and learns at the bedside that he has to study something more than the disease and that to render the fullest meed of service as a physician he must come to know, patiently, tenderly and, in the broadest sense, sympathetically, his brother man.

Here, too, he learns that his own feelings and emotions must be subordinated to the one purpose of his greatest help efficiency; that here, as in all scientific work, his personal equation must be reduced to a minimum and that he must lose himself in the effort to think wisely and judge well for others.

In former times, not many years ago, the bedside teaching was provided under a system corresponding to that of apprenticeship in trade, and the student gained his clinical experience through association with some active general practitioner; but to-day, with the aggregation of population in cities and the consequent establishment of hospitals, these institutions are made to furnish the clinical material necessary for instruction, thus fulfilling one of their important obligations to the community which supports them; for while the first purpose of the hospital is to provide for the care of the sick, no such institution does the just measure of its work unless its benefits extend beyond its walls through the education of those whose lives are to be pledged not only to a warfare against disease, but to an effort toward its prevention.

From an economic standpoint the hospital may be defined as an institution in which capital and skilled labor combine to provide such members of the community as are temporarily disabled and without means of support, with the maintenance and care which shall fit them to become again self-supporting and active community factors.

It is a free repair shop for human machines, and the capitalist who contributes to its support does so with the basal, though perhaps not with the defined understanding, that his contribution is returned to him, through the community, in the lesser number of incapacitated and dependent machines, while the physician who furnishes the skilled-labor contribution finds his return not only in the same manner as the capitalist, but in the opportunity which is given him of fulfilling his duty to humanity with less expenditure than if he did it at his own charge, and with better effect, under conditions which inure greatly to his own well-being and usefulness.

But the hospital of to-day is something very much more than a mere repair shop; it is a school full of object-lessons in the application of those qualities which are the uprights, the girders, and the binding-rods of the modern social structure. In the first place, it is the most absolutely clean of all human habitations, and the present splendid successes of surgery in the amelioration of suffering and the preservation of life are due not only to the application of trained skill and intelligence, but to its operations under conditions of absolute sterilization which are microscopic in their minuteness.

Not only is the hospital a lesson in physical cleanliness, but, if justly administered, it is morally clean as well; for so important is its service, so often does the issue of a life depend upon the observance of some apparently minor detail, that its work must be done under the strictest discipline; order, obedience, alertness and complete devotion to the duty in hand must be commanded within its walls.

Under such responsibilities the position of superintendent of a hospital is a serious one, calling for administrative ability of no mean order.

Gradually with the growth of urban hospitals these posts have come to be filled by selected men who, from previous education, along other than medical lines, or from training in the hospitals themselves, have acquired the ability to deal with questions of structure, repair, lighting, heating, ventilation, equipment, food-supply, and the details having to do with a housekeeping for hundreds of patients and nearly hal that number, the usual ratio, of medica house-officers, nurses, and attendants.

Many hospitals are administered by women who have had their preliminary training in such institutions as nurses; women are also supplementing the general administrative work as superintendents of hospital training-schools for nurses.

The entrance of women into hospital life and work is one of the sociological advances for which the medical profession is mainly responsible, a responsibility having a serious ethical as well as an important economic side.

Under present conditions the training-schools furnish to the hospitals a much better service than could otherwise be obtained, one which has contributed much to the precision and fidelity of the work done and which has moreover exercised a generally beneficial effect upon the morale of the patients.

The course of study of the hospital-trained nurse is a severe one, usually of two years' duration, but now being lengthened to three and four years; the woman who enters upon, and continues in it, has a liberal education in the deterrent side of human life and, if she graduates well, comes out of the hospital to enter individually upon a vocation in which she is likely to find herself set apart from the society about her, even more than is the physician.

For, while the physician has his medical societies and other social relationships with his fellows, the nurse has only the affiliation with her training-school and hospital; that she often finds it difficult to cope with the competition in her profession and the discomfort of an uncertain income, is shown by the tendency to re-enter institution-life, even at moderate salaries, among nurses who have been in private practice.

The trained nurse has now been in existence, as a community factor, a sufficient length of time to make statistical estimates possible, and it appears that the active professional life of the nurse, outside of institutions, is covered by an extreme limit of fifteen years, and that her average annual income is that of the average woman teacher.

The teacher has a regular stipend, allotted hours of work, and a definite holiday; the nurse, in private practice, has no regular stipend, no protracted leisure, and leads an economically irregular life, with occasionally extraordinary demands upon her strength and powers of endurance.

The medical profession, which has created the trained nurse, to its own great advantage and with considerable extension of its helpfulness, owes a debt which should be acknowledged not only individually but generally.

The provision for lodgment of nurses in separate buildings where they may, when off duty, have the comforts of a home, is a step in this direction; here also the training in the hospital is supplemented by instruction in housekeeping, purchasing, and diet-kitchen work, and the nurse thus educated who goes into private practice and becomes temporarily the member of a household, does so with a better knowledge of the perplexities which may beset the housemother when illness cuts across the line of home affairs.

Another question which is coming to the front is that of the establishment of co-operative training schools, in which a nurse, having served her probationary period and a year or more in one hospital, is passed on to a second and third hospital, either of a different class or in another city, returning to the first hospital for her final service and graduation. Under this plan the nurse, admitted only on an entrance examination and first trained in a general hospital would continue her studies in a lying-in hospital, a children's hospital, some special hospital, and in a hospital for contagious diseases, and the higher educational standard required of applicants, the length of the course and its completeness, would tend not only to furnish a better class of women, more competent to succeed in private practice, but would help to prevent that over-crowding of the nursing profession already apparent.

Leaving now the hospital, a term here meant to include asylums, convalescent homes and similar institutions which are his particular province, and passing over questions, interesting in themselves in regard to the working relationship of medical staffs and boards of managers, let us consider other directions wherein the physician finds opportunities for the acknowledgment of his citizenship.

The medical supervision of public schools, of recent inauguration, demanded as a necessity in view of the opportunity afforded for the spread of contagious diseases through the medium of these aggregation centers, is opening the way to a much larger sociological service than was at first expected of it; for, where medical inspection has been fairly established, the examiners find themselves confronted with questions of the proper seating of school children, of the provision of school lunches, of proper lighting, ventilation and sanitary accommodations and of the detection and setting aside for compensatory educational advantages children whose defective sight or hearing puts them below the average of their fellows.

It is in schools for the defective, however, that the doctor finds his especial work, and the generous provision now made for the care of feeble-minded and backward children, the blind, the deaf, and latterly the crippled, gives him a large opportunity for elucidative study leading toward the betterment of the condition of those whose inheritance or personal misfortune have made them a charge upon the community, not only for assistance, but for encouragement toward turning their moderate capital in life to the best account.

The distinction between lack of perceptive capacity and lack of sense-transmission is frequently represented only by a thin and shadowy line, and the partition classification of dependent and imperfect children is often one of the most exacting of the moral responsibilities of the doctor.

Children who are regarded as backward, or even idiotic, are sometimes found on careful examination, to be merely creatures shut within themselves by the closure of normal channels of communication, and the bringing of such children into touch, through the education of their tactile sense, with the human companionship which makes life worth living is worth far more than all it costs in time or effort.

In such cases as these the child has virtually no desultory memory, all impressions received come mainly through one channel and the memorizing capacity is in proportion to the concentration effort in reception, the nervous energy of the child, moreover, instead of being expended in an effort at reception through several sense organs, is limited to a distinctively volitional one, and in place of being used in the elaboration of different methods of expression, is devoted almost solely to perception.

The intelligence, slowly educated by an expenditure of effort on the part of the child, is, reactively, constantly increasing the perceptive power, so that when, through the utilization of a quickened tactile sense, new forms of expression are afforded, the concentrated nervous energy bursts its bounds in a flood of questions and there is no fairyland imaginable which will compare in its wonders to that into which such a child is admitted through the educational portals of the kindergarten for the blind.

The first attempts at the education of the so-called deaf mutes, but mutes only because of the lack of hearing and of training, began naturally through the medium of the signs and gestures which these unfortunates substituted for the inadequate utterance of which some of them were capable. While succeeding in imparting a good education through the medium of the manual and gesture language, this method created a class set apart by itself because of its inability to communicate, through any other medium than that of writing, with its hearing and speaking environment.

The recognition in an educational process, of so serious a defect as the creation of a distinct class in the community, subject to the temptation of intermarriage and the consequent possibility of class perpetuation, together with a better knowledge of the fact that many of these people had an amount of hearing power sufficient to enable them to perceive sounds which they themselves made, brought about the gradual introduction into the manual schools, of a system of voice-training and lip-reading, which has so far gained ground as to lead to the establishment of schools devoted exclusively to this method.

The growth and progress of schools for the deaf in the United States since the establishment of the first school in 1817, may be judged from the fact that the twelve original pupils at that date have now increased to almost ten thousand, in over eighty schools, and that very nearly half this number of pupils are being taught articulation.

With the progress of a method of education which is ultimately destined in the main to prevail, since it is in the line of that sociological advance which seeks to make and to keep each unit a viable member of the community, a more precise determination of the amount of hearing possessed by each pupil, and the possibility of its improvement becomes a matter of great importance.

Under the auspices of the National Association of Teachers of Speech to the Deaf, acting in co-operation with one of the bodies forming this Association, the American Otological Society, a systematic examination of all pupils in schools for the deaf throughout the United States has been undertaken.

The purpose of this investigation is to provide not for what might be called a census-taking, but for the establishment of continuous special medical examination of the pupils, firstly, for their immediate advantage, and, secondly, to make records upon a uniform basis suitable for comparison and tabulation.

The work, already begun as a preliminary investigation in the Horace Mann School, shows that out of 150 children, set apart by their infirmity and specially educated, fully 8% are capable of being restored to an amount of hearing which will enable them, in some instances with the help of artificial aids to hearing, to take their places in the society of people of normal average hearing, while still others, to the extent of an additional 5%, can be so far improved as to be materially aided in their power to acquire well-modulated articulation.

Between 10% and 15% of these cases, in addition to those already mentioned, are found to illustrate the truth of the saying that disuse is abuse, for in them it is possible, by means of speaking-tubes and other appliances for the direct communication of sound to the perceptive organs, to awaken what may be called, for want of a better term, the latent hearing, and make it, if not a means of communication of consecutive thought, at least useful for improvement of the articulation.

With the continued prosecution of this investigation there is opened a large field for the study of the causes of high grades of deafness in young children, and one leading to better knowledge of possibilities of prevention.

A more recent effort at compensatory education follows lines laid down nearly 70 years ago in Bavaria, and since extended to other countries in Europe, finding its most marked success in Italy.

Five years ago there was opened in Boston a charitable institution which deserves more than passing notice for the comparative novelty, as well as the value, of the work undertaken, and for the promise which it gives of extension.

The Industrial School for Crippled and Deformed Children, beginning with 11 pupils in 1895, now with quadruple that number and a large waiting list, has served as a suggestion for the establishment of other institutions of the same or similar character in Milwaukee, Chicago, and Baltimore.

In New York a school of this kind is now projected, and in Philadelphia Mr. Widener has recently given the sum of two million dollars, the income of which is to be expended for the care, education, and industrial training of cripples.

"Strange it is," says Dr. E. H. Bradford, the practical founder of the Boston school, in a paper not yet published, but from which I am permitted to quote, "that while in every civilized country the insane, the blind, the dumb, the epileptic and the idiotic receive careful attention, but little heed is paid to the education of the most deserving of all unfortunates, namely the crippled.

"The cripple is left to the almshouse or allowed to remain in a back room at home idle, useless, petted, often the only wilful member of the family whose misdirected kindness aids in ruining his character; hampered by disease and deformed, he is doomed to the injurious influence of idleness.

"Crippled children can be grouped under two heads: those who are suffering from a chronic disease which, during their childhood, either prevents their attending school altogether, or else where their attendance is interrupted or prevented because their feeble condition will not stand the fatigue of a school day adapted only for strong children. The majority of these, if they receive good care, good food, good air, under proper medical supervision, recover with more or less resultant deformity and, although handicapped as breadwinners, are eventually able to do something as workers, that is, if trained during their childhood, may become skilled in sedentary occupations, but if uneducated, are necessarily idle and useless.

"The second class comprise those permanently crippled either by congenital deformity or by paralysis. They can never recover from their ailment and are permanently excluded from the use of their legs or arms. Special instruction is needed for these and special avenues must be made for them for certain kinds of work which they can be taught to do with the aid of suitable apparatus designed for them. This class can be of use to the community in many instances, as their affliction frequently develops a concentrated ability in certain directions, not found in more active or healthier persons. If they are unable to become producers to a large extent, yet in many instances they may be trained into workers contributing to their support. They are saved from the curse of idleness and in rare instances may develop unusual and useful talent."

To make provision for these two classes in a day school it is necessary, or at least advisable, to furnish means of transportation under conditions favorable to the most helpless, and in the school itself, there must be, in addition to the ordinary recitation and study rooms, rest rooms with reclining chairs or beds, rooms for the training of the pupils in various occupations, and a diet kitchen from which food may be dispensed.

To meet these peculiar conditions the staff of teachers must be supplemented by a trained nurse, and there should be regular medical visitors, preferably men on service in orthopedic hospitals.

The census of 1890 gives the number of feeble-minded, both children and adults, in the United States as a little less than one hundred thousand; but one of the best authorities in the treatment of this class of dependents thinks that there are probably four to every thousand of the population, or a total of very nearly three hundred thousand. Of this number about one in thirty only are in institutions and the remainder are scattered throughout the community, some in their own homes, where they are the objects of solicitous care and affectionate regard, others and the larger proportion, in almshouses, in prisons, and on the road as tramps.

Their number is apparently increasing. In 1860 there were six hundred to the million inhabitants, in 1890, fifteen hundred to the million; and they propagate their kind; with them are linked the variable and occasional criminals, as distinguished from the criminals having criminal trades, and about the borders of this realm of the unfit circulate the merely idle, the dissolute, the profligate and the debauchee.

The differentiation of these classes, the sorting out of this waste humanity, the utilization of what is good in it and the protection of that which is feeble and useless constitutes one of the most intricate problems of modern social life.

He who holds the key to a situation, is in a measure responsible for the situation and the key to this particular problem is in the hands of the doctor more than in those of any other citizen.

He, more than any other, as a necessity of his education, has been brought personally into contact with the deficient, his active life is spent in drawing comparisons with a normal standard of which, if he is to do his work well, he must constantly seek to keep himself, physically, mentally, and morally, an example.

It is evident that among the many lines of sociological activity prescient of the growing intelligence and increasing public conscience of the people, this work of analysis of human waste and of discrimination out of which grows helpful suggestion is particularly the province of the doctor.

A measure of work of this sort should be commanded of the medical profession by the community, not that the medical profession is not already engaged in such work and does not find in it fruitful opportunities, but that to command is to sustain and to support, and the public could with advantage make the labors of the physician for the common welfare more productive than they are at present.

The experience which has led to the substitution, in the hospital supported by private charity and in the municipal hospital, of an educated and trained physician for the man of business or the politician as superintendent, should serve the same purpose in our public institutions. The doctor is ready and willing, and the number of medical men who would accept positions of this kind at moderate salaries under conditions which would give them time and opportunity for studious work, is steadily increasing.

The popular idea of an almshouse is often very much that it is a place for the storage of decrepit bodies past usefulness, an institution paying an annuity in food and lodgment to such members of the community as have not had the fortune or the foresight to provide for their inactive years.

It is partly to the prevalence of this idea that institutions of this class have been public jetsam stranded on the shores of the current of community life; but, the stream of humanitarian progress increasing in volume and growing ever stronger, is lifting them, they are coming to be regarded more as hospitals, administered more upon the hospital plan, and in several of the largest city almshouses of this country the changes which have taken place, to the betterment of the inmates, under the influence of a regular medical visiting staff, supplemented by salaried house-officers and trained nurses, is most gratifying and promissory of still better conditions.

The same influence is at work in the domain of penology; prisons everywhere are steadily coming to be less punitive, more reformatory, and the in determinate sentence is a recognition, not only of the possible good underlying apparent evil, but also of the fact that betterment of the physical condition, as well as of the mental point of view, is a necessary basis for a healthy morality.

Dr. Coulston, of the Royal Edinburgh Asylum, illustrates the fact that purely mental and moral causes play but a small part in the production of insanity, as compared with causes bodily and physical, by the statement that of cases examined by him only 11.5 per cent. were due to mental shock, the remainder being the outcome of causes acting on the brain through the body; drink and dissolute living, faulty development, hereditary disposition and the like; furthermore, he gives it as his opinion that the late epidemic of influenza caused more insanity than all the public and private anxiety in connection with the war in Africa.

The weakness of will and the inability to sustain healthy mental exertion, evident in asylums for the insane, are found also, though in lesser degree, in houses of refuge, almshouses and prisons, and the parallelism of conditions of the mentally, morally and physically defective, with the interchangeability of their classification, are nowhere more compactly observable, more readily made subject of study, than in the public institutions departments of our great cities with their shifting population passing from one institution to another, a pauper, a drunkard, a malefactor in succession, but always a public charge.

These departments, classed in the civic roster with the departments of public works as channels of expenditure, fiscal administration and possible political preferment, have come to be regarded, because of their humanitarian function, as fields for the exploitation of philanthropic effort.

Worthy and commendable as this is and most welcome as opening the way to still better defined conditions, it fails of its fullest efficiency because it lacks the necessary foundation of accurate information in regard to the subjects with which it has to deal and, under the ordinarily existing political conditions, fails of continuity of effort.

The care of the physically, mentally, and morally sick is so very serious a part of the business of life, its judicious exercise so important to the welfare of the whole community, that it is best placed, unreservedly, in the hands of those whose training has fitted them for its obligations and who have learned, by repeated experiences, that an emotion however good, or an impulse however philanthropic, unexpressed in carefully considered and continuously beneficial work, sinks to the level of a personal gratification.

The ideal institutions department is that which, removed entirely from political control, but still a part of the city government, is adjusted and administered upon the hospital basis, bringing to its service, as does the hospital, the conjoint efforts of the man of business and the physician. The actual work is in the hands of a general superintendent or commissioner, a medical man of large experience and institution-training at a salary enabling him to devote his whole time to the duties of his office; under him, as the heads of subdepartments, salaried officials, among them medical men and women and house officers, either senior medical students or recent graduates, holding positions the equivalents of those in general hospitals.

The whole under control, both as to appointment, general management and expenditure, of a board of trustees, the majority physicians, and an unpaid visiting medical staff.

The existence of such an institutions department would mean the establishment of a biological station, which would be the means of bringing the greatest benefit to its inmates and at the same time would be an educational center from which would emanate, for professional and public information, deductions derived from conscientiously applied scientific observation.

Affiliated with the Institutions Department in cities is the Department of Police; through the police station pass a large proportion of the inmates of the city institutions and, under police supervision and inspection, live the defectives with whom the medical profession could, advantageously, be brought into more recognizedly effective contact, either by medical appointments on police commissions or by the creation of medical bureaus as a part of police departments.

Such bureaus, in addition to rendering the professional services for which private practitioners or contract surgeons are usually employed, would provide responsible care and carefully trained investigation in cases of accident or violence with correspondingly accurate records, and could be made to do valuable correlative work with the institutions, the police and the hospitals.

It has been said by the trainers of youth that they do not get from the doctor the help expected and needed in the inculcation of those lessons which teach the moral value and moral use of the human body and are the substructure of healthful living, but it is doubtful also if the doctor has as yet had his sufficient opportunity.

The recent endowment in a large university, of a professorship of hygiene, with the stipulated condition that the appointment shall bear with it the obligation of a closer relationship with the lives of the students, is an important and welcome step in this direction, and the chair so endowed might be made the center of a Department of Civics.

Still another relationship, which may be broadened beyond its individual phase, is that between the doctor and the clergyman, and recent experiments based upon a proposition that the divinity student should have opportunities to see the practical side of hospital and other institution work under medical guidance, are so promising as to lead to the serious consideration of making this a definite part of regular divinity-school instruction, while the growing appreciation of the importance of medical missions, with the understanding that they are to be in the charge of thoroughly educated physicians, and the demands for instruction in medical ethics in our medical schools show a tendency to approximation in the work of two professions which began originally as one.

It would be interesting to take up in detail other and various channels through, which the doctor, because of the elaboration of modern community life, finds recognized opportunities for his outgo from the unit to the mass; such, for instance, as questions of water-supply and sewage disposition, food and drug adulterations, asylum and hospital construction, health and quarantine regulations, hygiene and physical training and to cite illustrative instances; but enough has been said to emphasize the fact that his principal value to the community springs from his intimate knowledge of the personal needs of his brother man.

His sociologic status is the outcome of this distinctive privilege, and his recognition and proper use of it, as the teacher of the individual and as the exponent of the beauty and righteousness of cleanly, wholesome and useful living, make his foremost duty to society.

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ALUMINIUM-MAGNESIUM ALLOYS.

THERE have recently appeared accounts of a 'newly discovered' series of alloys of aluminium and magnesium which are considered by their discoverers peculiarly valuable and promising. Dr. Mach, for example, has named such alloys 'magnalium.' Possibly other investigators may not be aware that this series was long ago investigated at the suggestion of the writer and in considerable detail in the laboratories of Sibley College. The writer published an account of the work in 1893 and it has been reproduced or summarized in several cases since.* The following are the tabulated results of such tests of strength of the two metals and their alloys as then determined. The succeeding graphic illustration of their variation of quality and the law of such variation is from a paper read by Professor Carpenter, in 1898, before the American Society of Mechanical Engineers and published in their transactions for that year.

TENACITY OF MAGNESIUM.

Number of Test Piece.	Diameter.	Breaking Load Lbs.	Breaking Load Lbs. per sq. in.	Elastic Limit Lbs. per sq. in.	Extension per cent.	Modulus of Electricity.
1	.433	3,500	23,800	8,800	4 2	2,040.000
2	.433	3,250	22,050	....	.....	1,860,000
3	.442	3,200	20,900	10,780	1.8	2,060,000
4	.435	2,900	19,500	8,400	2.5	1,830,000
5	.424	3,500	24,800	7,090	3.1	1,930,000
6	.432	3,300	22,500	....	2.3	....

ALLOYS OF ALUMINIUM AND MAGNESIUM.

Number of Test Piece.	Percentage of Magnesium.	Specific Gravity.	Breaking Strength. lbs. per sq in.	Elastic Limit. lbs. per sq. in.	Modulus of Elasticity.
1	0	2.67	13,685	4,900	1,690,000
2	2	2.62	15,440	8,700	2,650,000
3	5	2.59	17,850	13,090	2,917,000
4	10	2.55	19,680	14,600	2,650,000
5	30	2.29	5,000	....	....

From this table it will be seen that, for magnesium, the

Average breaking strength is	22,250 lbs. per sq. in.
Average elastic limit is........	8,870
Average elongation is..........	2.8 per cent.
Average modulus of elasticity is........................	1,945,000

It is noticeable that though the density of the metal is only two-thirds that of aluminium it has one-half more tensile strength; the latter averaging, pure, about 15,000 pounds.

The addition of magnesium to aluminium reduced ductility steadily with rising proportions and, at one-third magnesium and two-thirds aluminium, the alloy was as brittle as glass. Magnesium refused to alloy with iron. The alloys with aluminium, where the proportion of magnesium is small, give promise of finding useful and valuable applications in the arts.

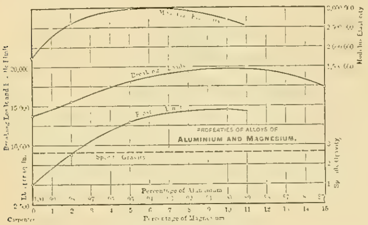
The series of tests of which the diagram

* For earlier work on properties of magnesium and its alloys, see 'Materials of Aëronautic Engineering,' *Transactions Aëronautic Congress*, Chicago, 1893; also *Sibley Journal*, April, 1894.—R. H. T.

'Magnesium as a Constructive Material.'—R. H. T. *London Machinery*, May, 1896; 'Industries and Iron,' May 22, 1896. Also Thurston's 'Materials of Engineering,' vol. iii., pp. 94–561.

'Mechanical Properties of certain Aluminium Alloys,' R. C. Carpenter; Trans. A. S. M. E., vol. xix., 1898, No. DCCLXXXIV.

is the record in graphical form were made in 1893 by Messrs. Marks and Barraclough in the course of regular graduate work in



the mechanical laboratories of Sibley College.* The writer had always anticipated useful employment of such alloys, since the properties of magnesium became familiar to him, in the experimental use of the metal for signal purposes in army and navy, 'in the sixties,' with the assistance of Admiral Luce and of General Myer, then Chief Signal Officer of the Army of the United States.

The volatility and combustibility of the lighter metal are elements of difficulty in its use in alloys, especially with those, as copper, which have a high temperature of fusion; but a little care and sometimes very simple special precautions will be found to readily evade such obstructions to its use.† The metal, weighing about two-thirds as much as aluminium and between one-fourth and one-fifth as much as iron or steel, has a more than proportional strength, and pieces of the metals having similar size will carry more nearly equal loads. The first at all complete studies of the constructive value of this metal and its alloys were made, on the initiative of the writer, as above, in the laboratories of Sibley College; to which laboratories he had turned over his collected material for that purpose, mainly, at the time, with a view to securing some definite knowledge of its value for the purposes of 'aëronautic engineering,' and with the intention, actually carried into effect, of reporting the outcome to the International Engineering Congress at Chicago in 1893. The result was to show that aluminium might be considerably strengthened by alloying with magnesium in small quantities as above; but that the alloying metal was itself stronger than the alloys, and that the presence of aluminium reduced the strength of magnesium.

The best comparison of these metals and their alloys is that by comparing the lengths of bars of the metal, suspended from one end, that can be carried without breaking. The extreme range of the tenacities of magnesium was between 20,000 and 30,000 pounds per square inch, corresponding to a

* Mr. Marks is now Assistant Professor of Mechanical Engineering at Harvard University and Mr. Barracough has charge of the Department of Electrical Engineering at the University of Sidney, N. S. W., of which institution he is an alumnus. Mr. Marks is a graduate of the University of London and of Mason College, Birmingham, England.

† The writer employed magnesium for illuminating and for signal purposes about the close of the civil war (1864–65), and, while stationed at the U. S. Naval Academy (1865–71) experimented with a variety of signal apparatus devised by himself for long-distance work, as above. The most successful forms of apparatus for this application of the metal were constructed for the use of magnesium in powder, in which a suitable proportion of sand was used to insure free flow as well as economy. The most successful form for other illumination, as photography, stationary signal lamps, theater tableau work, etc., was the ribbon lamp, of which latter a large number were in use when the electric light entered the field and threw them out. See 'A New Marine Signal Light,' describing this apparatus (patented in May, 1866), *Journal Franklin Institute*, 1867, R. H. Thurston, in which paper the writer gives the costs of signalling: sixty cents by the magnesium apparatus employed by him, and six dollars for the same message sent by the then usual Coston signals. The marine apparatus was taken by Admiral Luce on his cruise to the Mediterranean in the summer of 1866, and the army signal was employed by General Myer about Washington. The latter is now in the possession of the writer. It was built from the designs of the writer by the American Magnesium Co. of Boston.

suspension of 30,000 to 40,000 feet. This is the equivalent of steel of about 100,000 pounds tenacity. Could the cast portions of the steam-engine be made in this material for our torpedo-boats or aëronautic and automobile machinery their weights would be reduced about one-half. It remains to be seen whether, the costs permitting, this change would be to any extent practicable. Dynamos have been constructed, in the shops of Sibley College, of aluminium and a gain thus secured for portable and automobile work of some importance, and it is possible that magnesium, with its higher tenacity and greater lightness, may prove the coming material for some such work. Costs will undoubtedly fall rapidly with increasing area of market.

R. H. Thurston.

SCIENTIFIC BOOKS.

La constitution du monde. By Madame Clémence Royer. Published by Schleicher Frères, 15 Rue des Saints-Pères, Paris. Containing 799 pages, 100 chapters, 92 figures, and 4 plates.

This pretentious volume is claimed by its author to contain a new and satisfactory philosophy of nature including everything from the geometrical structure of molecules to a theory of the evolution of worlds. In a somewhat remarkable preface the author expresses in forcible terms her contempt for those philosophers who maintain that certain things are unknowable, and asserts that their speculations were advanced to enslave the minds of men and support the dogmas of theologians. The following quotations of remarks concerning scientific subjects will indicate her attitude of mind: "The kinetic theory of gases is certainly a romance conceived by the imagination of a German mathematician." The non-euclidian geometries "founded on sophistic generalizations of analysis * * * have for their result and their end, the clouding of the intellect in undermining the foundations of rational certitude, to the profit of those who are attempting to reduce mankind * * * to the *credo quia absurdum* of blind and unquestioning faith."

The ideas advanced upon scientific questions are not worth the space that it would require to enumerate them, much less to make any critical comments. They indicate, as is in reality confessed in the preface, that the author has read, though widely, with a mind strongly biased by preconceived notions, and they show at every point a lamentable lack of scientific training and spirit. The contents of the 99th chapter are sufficient to illustrate the statement. The author in her 'evolution du monde' supposes that at some remote time a planet from exterior space struck Saturn a glancing blow greatly accelerating its rotation; that the Saturnian oceans and portions of the solid crust were hurled off and formed the rings, which are ice, or perhaps aluminium; that the striking planet was broken up forming the satellites of Saturn, Jupiter, Uranus, Neptune, Mars, and the Moon, the asteroids, the meteor streams; that Venus and Mercury have no satellites because they were on the opposite side of the sun when the collision occurred; that the Moon and the satellites of Mars move with less linear velocity than those of the larger planets because they are so far from Saturn that the velocities of the flying fragments had largely died out before they reached their respective primaries; and that the second satellite of Mars 'by a remarkable exception does not fulfill the laws of Kepler.' The figure inserted in the chapter makes the theory very clear.

It is to be regretted, for the sake of the author who devoted so much time to writing the book, and for the sake of Madame Valentine Barrier who bore the expense of its publication, that it is impossible to say that the work is worth reading.

F. R. M.

The Chemistry of Soils and Fertilizers. By Harry Snyder, B.S., Professor of Agricultural Chemistry, University of Minnesota, and Chemist of the Minnesota Agricultural Experimental Station, Easton, Pa. The Chemical Publishing Company. 1899. 12mo. ix + 277 pp. Price, $1.50.

This book is the outgrowth of courses of instruction given at the University of Minnesota "to classes of young men who intend to become farmers, and who desire information that will be of assistance to them in their profession." It aims to give "the principles of chemistry which have a bearing upon the conservation of soil fertility and the economic use of manures." The author has performed his task in a very satisfactory manner. He has treated the subject logically and systematically, giving first the scientific principles, and then laying stress on their practical application, but not to such a degree as to make the work a hand-book instead of a text-book. The historical development of the subject has not been neglected, though naturally the treatment has been very condensed.

Notwithstanding the general excellence of the work, there are certain errors and defects which cannot be overlooked. The language is, at times, too condensed for clearness, as, for example, in the description of the analysis of soils on page 74. The writer has a habit of leaving out the comma in sentences like these, 'that produced from cellulose bodies as sawdust,' 'produced by each material as green clover, oat straw.' It is stated on page 42 that "the additional amount of water in the humus soil may cause the soil temperature to be lower than that of the sandy soil. While the humus soil absorbs more heat than the sandy soil, the heat is used up in evaporating water." The heat is used up in warming the water, more than in evaporating it; the specific heat of soils being from 0.2 to 0.4, as stated in the next paragraph. On page 93 the statement is made that, "the non-nitrogenous compounds as cellulose, starch and sugar undergo a fermentation but seem to possess little, if any, power to form humates in the soil." And the third sentence reads, "straw, sawdust and sugar, materials rich in cellulose and other carbohydrates, yield a humus characteristically rich in carbon and poor in nitrogen." These statements appear inconsistent. The table on page 94 is not correctly arranged. On page 115 the statement is made, "like the nitrates and nitrites, the ammonium compounds are all soluble and hence cannot accumulate in soils which receive an average amount of rainfall." This leaves a false impression, for ammonium compounds are fixed by soils almost as readily as potash, becoming soluble with difficulty (1 part in 10,000 of water), while the nitrate and nitrites are not fixed, but wash out with great readiness. The fact that ammonium salts are fixed by the soils is not mentioned in the chapter on fixation.

This book is, on the whole a very good one; it is cordially recommended to the attention of all instructors in agricultural chemistry, and, while not written with this end in view, it is recommended to those agricultural chemists who desire to obtain a survey of the rapidly widening field of research relating to soils and fertilizers.

G. S. Fraps.

A Short History of the Progress of Scientific Chemistry in our own Times. By William A. Tilden, D.Sc., F.R.S. Longmans, Green & Co., London, New York, and Bombay. Pp. x + 276.

The task which Dr. Tilden set before himself in the preparation of this book was to give in broad outline a sketch of the development of chemistry during the period of the Victorian era. The subject has been treated topically rather than chronologically, and the method of treatment chosen is abundantly justified in the result. The topics selected are: Matter and Energy; The Chemical Elements; Atomic Weights; Classification of the Elements; Valency and the linking of Atoms; Synthetical Chemistry; Stereo-chemistry; Electricity and Chemical Affinity; Liquefaction of Gases. An exhaustive historical treatment of these topics does not, of course, lie within the scope of the work. Indeed, its value depends very greatly on the fact that the author has known so well what to select, and because the topics selected have been treated with sufficient fullness to be interesting and intelligible to any one possessing an elementary knowledge of the subject. The book should find a large field of usefulness.

W. A. Noyes.

Outlines of Industrial Chemistry. By Frank Hall Thorp, Ph.D., Instructor in Industrial Chemistry in the Massachusetts Institute of Technology. A text-book for students. New Edition revised. New York, The Macmillan Company. 1899. Pp. xvii + 541. Price, $3.50.

The excellence of Dr. Thorp's book is evidenced by the appearance of a second edition within one year after the printing of the first. The first edition was reviewed in SCIENCE, Vol. 9, p. 150. Very few changes, further than the correction of a few errors which have been brought to the author's notice, have been made. The book well deserves the success it has achieved.

W. A. NOYES.

GENERAL.

IT is proposed to publish, under the editorship of Mr. W. L. Sclater, director of the South African Museum, a series of volumes dealing with the fauna of Africa south of the Zambesi. The northern limits of South Africa, as treated in this work, will be a line drawn from the Cunéné River on the west to the Zambesi at the Victoria Falls, and thence along that river to its mouth. Within it will, therefore, be enclosed the British colonies of the Cape and Natal, the two republics of the Transvaal and the Orange Free State, the southern half of the Chartered Company's territory, German Southwest Africa, and that portion of Portuguese East Africa which lies south of the Zambesi. The first volume, by Arthur C. Stark, M.B., containing Part I. of the birds, will shortly appear, and it is hoped that that relating to the mammals, by Mr. Sclater, will be ready for publication during the course of the present year. The work is published by R. H. Porter, 7 Princes St., London.

IN *The Indians of Southern Mexico* Frederick Starr, of the University of Chicago, presents some of the results of his several expeditions to Mexico. The chief objects of these expeditions was the study of the physical types of South Mexican Indians. Three methods of work have been followed—measurement, photography and bust making. The tribes studied live among the mountains, and some of them—as the Triquis, Chontals and Juaves—are almost unknown to students. In the photographic work Professor Starr has secured portraits, groups, scenes in daily life, views of houses and towns and of scenery. For portraits plates 5x7 inches were used and front and profile views made of each subject; for full figures and occupations 5x8 inch plates were used; for large groups, architectural subjects, villages and landscapes 8x10 inch plates were employed. Hundreds of negatives have been made representing the tribes of the States of Michoacan, Mexico, Flaxcala, Puebla and Oaxaca. From this series a selection has been made for publication. The book contains one hundred and forty-one beautiful photogravure plates, 11x14 inches in size, printed on heavy plate paper and well bound. They are accompanied by thirty-two pages of descriptive text. On account of its great cost the work is a limited edition, but it will have permanent value.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Journal of Geology*, Vol. 8, No. 2, February–March, 1900. Besides the reviews and notes on recent publications, this interesting number contains: 'The Nomenclature of the Feldspathic Granulites' by H. W. Turner. The author advocates the naming of the rocks in accordance with their mineral molecular composition and in the case of the feldspathic granulites, to abandon the term plagioclase, which expresses a mixture of two or more kinds of molecules, and substitute the more descriptive terms for the rocks which contain the larger per cent. of the single molecules such as orthosite, anorthosite, albitite, oligosite, andesinite, labradite, and anorthitite. When quartz is abundant then the terms should be compounded as quartz-orthosite. If an accessory mineral term is introduced into the name it should take the adjective form as quartziferous syenite. 'The Geology of the White Sands of New Mexico'; with three plates, by C. L. Herrick. The geological features of the regions east of the San Andreas and Orange Mountains of New Mexico and those bordering the great white sand plains are discussed, and the opinion is expressed that the white sands are derived from the weathering of the ridges of gypsum and are entirely dune sands, that the alkaline and saline deposits of the region are derived from the red beds (Permian and Triassic) and the associated saline and gypsiferous members. The copper deposits are thought to have a similar origin also. The suggestion is offered that the low depressed areas and local basins are caused by the leaching out of the soluble materials from the underlying beds. 'The Origin of Nitrates in Cavern Earths,' by William H. Hess. The author finds from a study of cavern earths and from many analyses that the nitrates are derived from the soil layers above the caverns and are carried into the caverns by the percolating waters and are finally left in the cavern earths by the evaporation of the water. 'The Calcareous Concretions of Kettle Point, Lambton County, Ontario,' by Reginald A. Daly. The article is illustrated with six reproductions of photographs of these noted concretions and after a somewhat extended discussion of the subject of concretionary growths, the author concludes that these particular concretions "were formed in place in the shales and antedate the period of joint development and final consolidation of the surrounding rock, that the local deformation of the shale accompanied the crystallization, that the energy of the deformation was derived from the change of volume induced by the breaking up of the bicarbonate into the monocarbonate and the fluid biproducts." 'Ants as Geological Agents in the Tropics,' by John C. Branner. The author concludes that the geological work of ants in the tropics is much more important than that of the earthworms in the temperate regions and he records a number of observations on the point. 'Variations of Glaciers,' by Harry Fielding Reid. A summary of the fourth annual report of the International Committee on Glaciers is given. Under the section of Studies for Students, Dr. E. R. Buckley gives a very comprehensive discussion of 'The Properties of Building Stones and Methods of determining their Value.' The author treats especially the economic phase of the subject.

W. G. T.

SOCIETIES AND ACADEMIES.

ZOOLOGICAL CLUB, UNIVERSITY OF CHICAGO.

MEETINGS OF FEBRUARY AND MARCH, 1900.

At the meeting of February 14th, Mr. W. J. Moenkhaus presented a paper entitled 'Some Stages in Hybrid Development' giving some of the results of his experiments upon the production of hybrids among fishes, and Miss Mary Hefferan reviewed Rand's papers on regeneration and regulation in Hydra. The following is an abstract of Mr. Moenkhaus' paper:

Of some twenty crosses made between some of our commoner marine and fresh water fishes there was not a single failure of impregnation, though many of the crosses were between very distantly related forms—soft-rayed and spiny-rayed species. The per cent. of eggs impregnated was, as a rule, quite large, but this bore no relation to the nearness of relationship. Two combinations gave beautiful instances of what a study of the nuclear conditions has shown to be dispermy, fifty per cent. of the impregnated eggs falling directly into four cells, the remainder into two. In all crosses segmentation was carried through. Four crosses went to completion of gastrulation, forming the neural tube, but no optic vesicles. The remainder hatched. From crosses among the trout it appeared that the formation of the tail is a difficult process. Considering in this connection the common phenomenon of infertility, it seemed that in hybrid fishes there were at least four pretty definite stages in development that are critical: (1) beginning and (2) close of gastrulation; (3) formation of tail bud, (4) formation of the sexual elements.

The nuclear behavior during fertilization and during degeneration in these partially successful crosses is being studied.

The session of February 28th was devoted to two papers; a review and critique by Mr. E. R. Downing of Delage's recent work on the fertilization and development of enucleated egg-fragments, and a review by Miss Anne Moore of Calkin's paper on 'Mitosis in Noctiluca.' A few of the more important points touched upon by Mr. Downing were as follows:

Delage finds in embryos produced by the fertilization of enucleated egg-fragments the normal number of chromosomes. He claims to demonstrate (1) a maturation of the cytoplasm corresponding to, but independent of, that of the nucleus; (2) that enucleated eggs resist hybridization as well as entire eggs and that, therefore, the nucleus has nothing to do with such resistance; (3) that the female nucleus is inert and the male excitable. The latter conclusion is drawn from the fact that the whole eggs did not fertilize in a drop of water as well as the enucleated fragments. His conclusions were criticised, for the whole eggs in abundant water all fertilized as usual. The only justifiable conclusion would be that confinement in a drop of water prevents fertilization of normal eggs, while it is not an unfavorable condition for enucleated fragments. The small available supply of oxygen may account for this. The second conclusion above given is drawn from contradictory results. The proper inference to draw is that the possibility of entrance of the sperm is determined in hybridization by other things than the presence or absence of the nucleus.

At the session of March 14th, a paper entitled 'The Derivation of Annelid Nephridia' was read by Mr. R. S. Lillie, consisting of a resumé and discussion of the various theories regarding the morphological significance of annelid nephridia.

C. M. CHILD.

THE PHILOSOPHICAL SOCIETY OF WASHINGTON.

AT the 517th meeting of the Society, held April 14th at the Cosmos Club, Professor Geo. L. Raymond, of Princeton University read a paper on 'Some Æsthetic Aspects of Music.' He showed that the one distinction between talking and singing lay in the sustained character of the tones of the latter. Birds, dogs or men chirp, bark or talk in unsustained tones at those who have interrupted them. They sing, howl or hum in sustained tones, subjectively and spontaneously. This explains why music need not convey definite intelligence, nor imitate external conditions. But natural music, as when a man hums, does represent moods, and may repeat what has been heard. Artistic music develops, according to the laws of form, phrases of natural music; and what these mean may be determined by the meanings of time, pitch, force and quality as manifested in intonations of speech as distinguished from the articulations of words.

Mr. R. H. Strother spoke on the 'Physics of the Phonograph,' and C. K. Wead discussed 'Modern Problems in Acoustics.'

The 518th meeting, held April 28th, was devoted to a paper by Mr. Lyman J. Briggs 'On the Absorption of Salts by Organic and Inorganic Substances,' followed by 'An Unscientific Account of a Scientific Expedition to Hawaii,' illustrated by lantern slides, by Mr. E. D. Preston and the exercises closed with a statement by Mr. R. A. Harris of 'A new way of indicating the Acceleration of a point referred to Polar Co-ordinates.' The author showed how the ordinary expression for the acceleration of a point moving in a circle, or how the resolution of the acceleration with reference to tangent and normal for any path (plain or twisted), does by its form indicate the resolution with reference to polar co-ordinates.

E. D. PRESTON,
Secretary.

NOTES ON PHYSICS.

ANALYSIS OF VOWEL SOUNDS.

PROFESSOR LOUIS BEVIER, Jr., describes in the *Physical Review*, for April, some interesting work in vowel analysis. The author magnifies the ordinary phonograph record by a mechanical-optical device, thus obtaining tracings which he subjects to harmonic analysis. He has thus far analyzed only the vowel *a* (as in father). He finds two mouth tones in this vowel. The higher and more characteristic mouth tone has a pitch of about 1150 ± 150 vibrations per second. The lower mouth tone has a pitch of about 675 ± 125 vibrations per second. The resonance corresponding to the higher tone is the more pronounced, and this tone varies less in pitch than the lower tone, with different voices.

DISSOCIATION THEORY OF THE ELECTRIC ARC.

PROFESSOR C. D. CHILD applies the theory of ionic dissociation to the explanation of some of the more prominent of the phenomena of the electric arc in the *Physical Review*, for March, 1900. Professor Child explains the curve obtained by Mrs. Ayrton (representing the fall of potential from carbon to carbon). He explains the peculiar light clouds which N. H. Brown found advancing at different velocities from positive and negative carbons in an alternating current arc, and he verifies the drag of the ions upon the vapors of the arc by the method employed by A. P. Chattock in case of discharge from point to plate. The question of the slow decay of the e. m. f. between the carbons of an arc, after the current ceases to flow (circuit broken), can be approximately answered in terms of the ionic theory. This e. m. f. would die away as the clouds of positive and negative ions near the carbon tips diffuse towards each other. The time required for this would be in the neighborhood of $\frac{1}{1000}$ second for an arc 1 cm. long, if we assume an ionic velocity of 3000 cm. per second per electrostatic unit of potential gradient, and the value of the counter e. m. f. at the instant of breaking the circuit (which would also be the real counter e. m. f. of the arc while running) could be easily calculated from Mrs. Ayrton's curve. Thus the curvature of Mrs. Ayrton's curve is the density of charge at each point; and from this the potential fall from carbon to carbon is easily calculated.

Practically, Mrs. Ayrton's curve taken in conjunction with the ionic theory of the arc settles the perplexing question of the counter electromotive force of the arc. Consider the freshly dissociated ions along the path of the arc. The positive ions have to be hauled up by the impressed e. m. f. into the cloud of positive ions, and the negative ions have to be hauled down into the cloud of negative ions. The work so spent is reversible, except that energy is being continuously dissipated at the carbons, as the ions in the clouds lose their charges. A small amount of energy is also dissipated because of the viscous drag of the arc vapors upon the ions. W. S. F.

CURRENT NOTES ON PHYSIOGRAPHY.

SHORELINE TOPOGRAPHY.

A SUCCESSFUL attempt has been made by F. P. Gulliver to trace a sequence in the development of shoreline forms, distinguishing those which are produced in the earlier stages from those which characterize the later stages of what may be called the 'shoreline cycle.' A large number of littoral forms recorded on maps from all parts of the world were thus classified in accordance with the processes of marine erosion as determined by local observation and general study, the results of the work appearing in a thesis entitled: 'Shoreline Topography' (*Proc. Amer. Acad.*, xxxiv, 1899, 177–258, 32 figures.) The author considers first the shorelines due to relative change of level of land and sea, and as yet essentially unmodified by sea action: these are the initial forms, on which the agencies of change then proceed to develop a long series of sequential forms, until interrupted by later movement. Systematic description and explanation is thus given to a large number of shore forms, such as cuspate forelands, off-shore bars, bars by which islands come to be tied to an adjacent mainland, bay-bars, spits, deltas, cliffs, and so on. Under each heading, a type example is selected and usually figured; additional examples are serviceably indicated by specific references to maps from many coasts. A bibliography of 100 titles is appended.

SHORE FORMS IN THE BRAS D'OR LAKES.

TARR'S account of cuspate forelands in the Bras D'Or Lakes of Cape Breton Island (*Amer. Geol.*, xxii, 1898, 1–12), is followed by a similar paper by Woodman (*Amer. Geol.*, xxiv, 1899, 329–342), describing additional shore features of the same irregular water bodies, where cusps, looped bars, single and double tombolos, and bars across the mouth, middle and head of bays are developed in remarkable variety. Through both these papers there seems to be some misapprehension of the share of work in making cuspate forelands attributed to waves and currents by Gulliver in his essays on the topography of the shore line (Cuspate forelands, *Bull. Geol. Soc., Amer.* vii, 1896, 399–422, and Shore-line Topography, as above). The former authors explain the cusps that they observed solely by what they regard as wave-action. The latter author refers the 'long-shore transportation that is involved in the production of cusps to currents which, in inland and tideless water bodies, he regarded as of wind origin. In so doing, it does not seem to have been his intention in the least to exclude from waves the power of moving shore materials, but to analzye the forces acting on a shore, much as had been done some years before by Gilbert, who wrote: "Usually, and especially when the wind blows, the water adjacent to the shore is stirred by a gentle current flowing parallel to the water margin. This carries along the particles of detritus agitated by the waves. The waves and undertow move the shallow water near the shore rapidly to and fro, and in so doing momentarily lift some particles, and roll others forward and back. The particles thus wholly or partially sustained by the water are at the same moment carried in a direction parallel to the shore by the shore current. The shore current is nearly always gentle and has of itself no power to move detritus" (*U. S. Geol. Surv.*, Monogr. i, 37). Tarr describes 'Shore currents of wind drift origin' in Cayuga Lake, and Woodman recognizes in the Bras D'Or Lakes, 'currents caused by the unobstructed forward movement of the top water under wave growth and motion, and lasting little if any time after the cessation of the wind.' It is precisely these currents which Gilbert and Gulliver seem to have had in mind as determining the direction of 'long shore transportation of gravel and sand, jostled by the waves. All may agree with a later writer that "one will never find [these] currents of sufficient power to transport pebbles,' if the currents are considered apart from the waves; but some might not agree with another writer that such currents should be classed 'under the general head of wave action." Certainly it is by wave action that a cobble is thrown upon the beach; but the systematic forms assumed by cusps and bars, of which the beach is but the higher part, suggests a control by the slow movement of a large body of water. The similarity between large cusps, such as Capes Lookout and Hatteras where the action of 'long-shore currents can hardly be doubted, and the small forms of the Bras D'Or lakes where the 'long-shore currents must be very weak, suggests that the processes of origin should be similarly analyzed for both large and small forms.

GLACIAL EROSION IN THE GREAT GLEN OF SCOTLAND.

W. T. BLANFORD, veteran geologist of India, writing "On a particular form of surface, apparently the result of glacial erosion, seen on Loch Lochy and elsewhere" (*Quart. Journ. Geol. Soc.*, lvi, 1900, 198–204), suggests that glacial action has strongly deepened the floor and smoothed the sides of the Great glen of Scotland. It is inferred that in preglacial time the streams of lateral glens were separated by advancing spurs which buttressed the sides of the Great glen. Now the spurs seem to have been truncated, producing the smooth and even sides of the glen, to which attention is especially directed. The lateral glens at present open 1000 feet above the floor of the Great glen, whose smoothed sides are very little eroded by the descending tributary streams. The change from the inferred preglacial form is taken to indicate glacial erosion of at least 250 or 300 feet of rock.

Main valleys thus affected by glacial erosion are called 'over-deepened valleys' by Penck, because they frequently contain lakes, and because their slope is often so gentle that the streams which now occupy them must aggrade their floor. The lateral valleys that open in the wall of the main valley at a considerable height above its floor, so that the side streams cascade into the main valleys, are called 'hanging valleys' by Gilbert, who has described many examples in an address on the Harriman Alaskan expedition (not yet published). Gannett has clearly explained the relation of hanging side valleys to their overdeepened main valleys in his account of Lake Chelan (*Nat. Geogr. Mag.*, ix., 1898, 417–428), in which the analogy between the valleys and beds of rivers and glaciers was clearly pointed out in terms very similar to those independently stated by Penck a year later (see SCIENCE, January 5, 1900, 34). An account of the overdeepened valleys of the Ticino in the Southern Alps is given by the undersigned in *Appalachia*, ix, 1900, 136–156.

W. M. DAVIS.

ANTIQUITIES OF ALABAMA.

'CERTAIN Aboriginal Remains of the Alabama River,' is the title of a paper by Mr. Clarence B. Moore, of Philadelphia. This memoir occupies pages 289 to 347 of Volume XI., 1899, of the *Journal of the Academy of Natural Sciences* of Philadelphia and is also issued as a bound reprint of same date. P. C. Stockhausen, the publisher, has left us nothing to wish for in paper and imprint. Sixty-nine illustrations of pottery, shell, stone and copper objects, a map of the Mobile and Alabama river region and an index accompany the text.

Some of the copper pendants figured are of exceeding interest. Pipes of earthenware, fish-hooks of shell and bone, disks probably for the ear lobe, incised shell disks and the decoration on the pottery are all worthy of study.

The author states that although the attention given by him to the Mobile and Alabama rivers does not compare with that accorded by him to the St. Johns river, Florida, and to the Georgia coast, yet it was fully ample to indicate that mounds along these rivers were of rare occurence and, as a rule, insignificant in size. He suspects that at many places the people were buried in cemeteries and that these being unmarked have largely escaped notice. The borders of Mobile and Alabama rivers were probably not so thickly settled as the St. Johns. This may be due to the fact that shad, bass and shell-fish are less abundant in the former. The shellheaps are insignificant compared with those covering acres along the St. Johns. Swamps and malaria may also have had their influence.

Quartz is more used than chert for points, a reverse of the facts for Florida and Georgia coast. The earthenware, although good and often tempered with shell, was not striking in type. In some of it Tennessee and Mississippi Valley influence is suggested.

The gritty ware of lower Georgia and its complicated stamp decorations were rare, but some sherds bearing decorations of the kind found in Georgia, Carolina and upper Florida were found. None of the highest type of gulf-ware was met and perforations for suspension were not common.

Plural burials of uncremated bones in single urns proved a fact new to science for the south-east, although plural burials of cremated bones may have been known. One case of cremation was found which, while almost totally foreign to this region, is frequently met in Florida and Georgia.

Mr. Moore's investigations are the first of a systematic nature to be carried on along the Mobile and the Alabama. This record of the results is a most happy addition to the already valuable Floridian library from his pen.

Harlan I. Smith.

A NEW PALEOLITHIC STATION.

A discovery of unusual importance is announced in the *Correspondenz-Blatt der deutschen Gesellschaft für Anthropologie, Ethnologie und Urgeschichte* for March. The announcement, as well as the discovery, is by Professor Gorjanović-Kramberger, Director of the National Museum of Geology and Paleontology at Agram, capital of Croatia, Austria-Hungary. The find was made on the bank of the Krapina, a small stream in northern Croatia, and consists of the paleolithic remains of man (pieces of the jaw bone with teeth, isolated teeth, parietal and occipital fragments, etc.), and chipped implements of stone, associated with Rhinoceros tichorhinus, Bos primigenius, Ursus spelæus, Sus, Castor fiber, etc.

These culture-bearing deposits, nine zones in all, occur in what might be called a rock shelter of stratified Miocene sandstone. Of the nine zones, the lowest only shows evidence of stream-action, and that at a time when the water-level was considerably higher than now. The eight superimposed layers are products of weathering from the overhanging Miocene sandstone. The thickness of the entire deposit measures 8.5 meters. The above mentioned animal remains occur throughout the series of layers, at the same time, on account of the relative frequency of certain remains, three faunal horizons are readily determined:

1 Castor fiber,
3–4 Homo sapiens,
9 Ursus spelæus.

It is pointed out that horizon 3–4 contains burnt human as well as animal bones. The bones are bright yellow and very friable, the phalanges and teeth alone being well preserved. The station has produced in all, more than one thousand fragments of bone. Unfortunately, the preliminary report gives little idea as to the character of the industry except to say that the implements are angular pieces of jasper and opal.

The appearance of charcoal, ashes, burnt sand, stone implements and bone fragments all the way from the second to the ninth and topmost layer, and the relatively large proportion of the human to the animal remains, will tend to increase the interest in Dr. Gorjanović-Kramberger's forthcoming, detailed and fully illustrated account.

GEORGE GRANT MACCURDY.
YALE UNIVERSITY.

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*CERTAIN LAWS OF VARIATION.**

IN a former paper† it was shown that the ova of the Echinoid *Strongylocentrotus lividus* were extraordinarily sensitive to their environmental conditions at the time of impregnation. For instance, by keeping the mixed ova and sperm in water at about 26° or 28° C. for an hour, the plutei obtained after eight days' development were some 5 per cent. smaller than those from ova kept at about 20° at the time of impregnation.

These observations were repeated and confirmed, in the case of *Sphærechinus granularis* as well as *Strongylocentrotus*, and others were made upon the reaction of *Strongylocentrotus* to environment in the later stages of their development. Thus after keeping the ova at a normal temperature for an hour at the time of impregnation, a portion of them was exposed to an abnormal temperature. After a few hours some of these were re-transferred to water at a normal temperature, and kept there for the remainder of development. A few hours later, some more of them were transferred, and so on. By measuring the larvæ after six or eight days' growth, the effect produced by various periods of exposure was determined. When the 'normal' temperature was 20° and the abnormal about 8°, it was found that the larvæ were diminished on an average 1.3 per cent. for each hour's exposure between the end of the 1st to the end of the 6th hour after impregnation; 0.3 per cent. for each hour between the 6th and 10th hours; and 0.2 per cent. for each hour between the 10th and 21st hours. When the 'normal' temperature was about 13° and the 'abnormal' about 20°, an increase in size was produced, amounting to 1.1 per cent. per hour during the 5th hour after impregnation; 0.4 per cent. during the 14th hour; 0.13 per cent. during the 46th hour, and 0.01 per cent. during the 120th hour. That is to say, in each case *the effect of temperature on the growth diminished regularly and rapidly from the time of impregnation onwards.*

When the ova were exposed to an abnormal temperature of 26°, an adverse effect of 4 per cent. was per hour produced during the first three hours. For the next four hours the effect was almost *nil*, and after that a *favorable* effect on growth ensued. This was about 0.4 per cent. per hour for the 16th hour, and 0.01 per cent. for the 80th hour. This change of reaction was accounted for by the fact that the fatal temperature, and therefore also the temperatures unfavorable to growth, rise during development. Thus the death temperature is 28.5° for ova, 33.5° for four hours' blastulæ, 36.5° for 12 hours' blastulæ, and 40.3° for six days' plutei.

The effect of change of salinity on the growth was also found to diminish rapidly with progress of development, hence probably a similar relationship would show itself for other conditions of environment.

What is true for echinoids is probably true for most other organisms, or is, in fact, a law of general application. Thus in man the rate of growth during the third week of embryonic existence is about 2400 times greater than between the 13th and 19th years of post-natal development. The reaction to environment must also be much greater during the earlier period, therefore, though not in the same proportion. Thus, in that the variability diminishes considerably during development—Minot has shown that it becomes halved through the post natal growth of guinea-pigs—retardations or accelerations of growth produced in the young animals must also become partly wiped out by the time the adult stage is reached.

By splitting up into groups the 20,600 measurements which have been made from time to time on *Strongylocentrotus* larvæ, according to the amount of effect which had been produced in their size by varying degrees of favorable and unfavorable environment, and by determining the average variability of the larvæ in each group, it was sought to prove the existence of a law of variability. This may be worded as follows: "An organism varies least

* Abstract of a paper read before the Royal Society on March 29, 1900, by Dr. H. M. Vernon, Fellow of Magdalen College, Oxford.

† *Phil. Trans.*, B, 1895, p. 577.

when it is best adapted to its surroundings, so that the less it is adapted, the more variable does it become."

SCIENTIFIC NOTES AND NEWS.

The Committee of Coinage, Weights and Measures of the House of Representatives has unanimously agreed to report as an amendment to the Sundry Civil Bill the measure establishing a United States Standardizing Bureau. A full account of this important measure was published in the issue of this Journal for May 4th.

In accordance with the recommendation of the Rumford Committee, the American Academy of Arts and Sciences has voted to award the Rumford Medal to Professor Carl Barus of Brown University for his various researches in heat.

The Academy has further granted from the Rumford Fund the sum of $230 to Mr. Arthur L. Clark of the Worcester Academy in furtherance of his research on the 'Molecular Properties of Vapors in the Neighborhood of the Critical Point.'

Two excursions were recently given under the auspices of the Geological Department of the Johns Hopkins University, in honor of Professor W. C. Brögger, of the University of Christiania, Norway, who completed, May 3d, his course of George Huntington Williams Memorial lectures on the Principles of Geology at the Johns Hopkins University. The first excursion was made upon the State steamer *Governor McLane* to southern and eastern Maryland to examine the several formations of the Coastal Plain, and was participated in by Mr. S. F. Emmons, of the U. S. Geological Survey; Professor B. K. Emerson, of Amherst; Profes- J. A. Holmes, of North Carolina, and Professors William Bullock Clark, Joseph S. Ames and Harry Fielding Reid, of the Johns Hopkins University. Several days were spent along the estuaries of the Chesapeake Bay in studying Cretaceous and Tertiary deposits.

Another excursion was organized by Professor Clark at the close of Professor Brögger's lectures on May 4th, the steamboat of the General Manager of the Chesapeake and Ohio Canal being placed at the command of the party, who made an all-water trip from Washington to Cumberland, in the heart of the Allegheny Mountains, spending six days *en route* in the study of the rocks of the Piedmont Plateau and the Appalachian Region, and subsequently passing a day as the guests of the Western Maryland Companies, studying the coal deposits of the Georges Creek Basin. Hon. C. D. Walcott, Director of the U. S. Geological Survey, and Messrs. Arnold Hague, C. W. Hayes, Bailey Willis and Arthur Keith, of the same organization, and Professors Clark, Reid and Matthews participated in this excursion.

The Franklin Institute has awarded an Elliott Cresson medal to Professor W. O. Atwater and Mr. E. B. Rosa for their respiration calorimeter.

Professor R. W. Wood, of the University of Wisconsin, has been elected a fellow of the London Physical Society.

Mr. Carl Hering has been appointed a member of the jury of award for the electrical group of the Paris Exposition.

Mr. S. Harbert Hamilton, former Jessup scholar in geological chemistry at the Academy of Natural Sciences of Philadelphia, has accepted a call to the Museum of Geology and Archæology of Princeton University.

George Grant MacCurdy, instructor in prehistoric anthropology at Yale University, has been made a corresponding member of the Society of the Institute of Coimbra, a society especially interested in developing literature, science and the liberal arts. Coimbra was once the capital of Portugal and is still the seat of its only university, an institution founded in 1290.

The seventieth anniversary of the birth of Dr. A. Jacobi, clinical professor of the diseases of children in Columbia University, was celebrated by a banquet in New York City on the evening of May 5th. Addresses were made by Dr. Joseph D. Bryant, Dr. William H. Thomson and Dr. Carl Schurz, and a poem by Dr. S. Weir Mitchell was read. A 'Festschrift' was presented to Dr. Jacobi, containing scientific contributions from fifty-three medical men representing eleven nations.

THE death is announced of M. Edouard Grimaux, the eminent chemist, member of the Paris Academy of Sciences and professor in the Polytechnic School of Paris, until deprived of this office by General Billot for maintaining his belief in the innocence of M. Dreyfus. We have no information that the wrong done him on that occasion had been repaired in view of the more recent developments. M. Grimaux's numerous publications include 'Equivalents, atomes et molécules' (1866), 'Chimie organique' (1872–1878), 'Chimie inorganique élémentaire' (1874–1879), 'théories et notations chimiques' (1884), and 'Lavoisier.'

DR. LANGDON-CARTER GRAY of New York City, a specialist in nervous and mental diseases and a past president of the American Neurological Association, died on May 8th at the age of 50 years.

THE death is announced of Dr. George Viner Ellis, who held the chair of anatomy in University College, London, for twenty-seven years and was the author of several works on human anatomy. He became a member of the Royal College of Surgeons 65 years ago.

THE Senate Committee on Commerce on May 10th agreed to report the Philadelphia Commercial Museums Bill carrying an appropriation of $200,000.

THE mansion of P. A. B. Widener, at Broad Street and Girard Avenue, Philadelphia, was presented to the city on May 8th to be used as a free library and art gallery. The gift is valued at $1,000,000, and it is said that Mr. Widener intends to endow the institution amply.

THE forty-first meeting of the American Society of Mechanical Engineers was held at the Grand Hotel, Cincinnati, O., May 15 to 18, 1900.

THE *Geologische Reichsanstalt* of Vienna will commemorate the fiftieth anniversary of its foundation at a meeting to be held on June 9th.

THE German Congress of Medicine which has been holding its sessions at Wiesbaden will meet next year at Berlin under the presidency of Professor Senator. In the German Surgical Congress Professor Czerny has been elected president in succession to Professor von Bergmann.

Two hundred and sixteen cases of the plague have now been reported at Sydney, of which number one-third were fatal. Twenty cases including thirteen deaths have been reported at Port Said. The disease shows no abatement in India. During the last week regarding which records are at hand there were in the Bombay Presidency 730 deaths, in Karachi 315 deaths, in Calcutta 648 deaths, and in Hong Kong the disease was increasing. Cholera is seriously epidemic in the famine districts of India.

THE *British Medical Journal* reports that all the arrangements have now been made for the carrying out of the experiments as to the prevention of malaria which were referred to by Dr. Manson in his address before the Colonial Institute. A mosquito-proof malaria hut has been constructed by Messrs. Humphrey, of Knightsbridge, and will be sent out to Italy about the first week in May. The experiments, the cost of which is to be defrayed by the Colonial Office, will be begun in June and continued till October, thus covering the malaria season. Dr. Luigi Sambon, lecturer of the London Tropical School of Medicine, and Dr. G. C. Low, a distinguished student of the school, have volunteered to be the subjects of the experiment by occupying the hut throughout the period indicated. Their business will be to keep themselves from being bitten by mosquitoes. Professor Celli has kindly offered every assistance in furtherance of the experiments, and will select a site for the huts within the area of his own field of experimental work on malaria. The Italian government has also expressed its sympathy with the objects of the expedition, and Professor Baccelli has promised his assistance. A series of correlative experiments will be made in England by exposing healthy Britons to the bites of malaria-infected mosquitoes, which will be supplied for the purpose by Professors Bignami and Bastianelli, of Rome. In this case, too, several persons have already offered themselves as subjects of the experiments, including a son of Dr. Manson's.

THE report of the Corporation of Glasgow on the Museums and Art Galleries, for 1899, shows the continued interest of the public in the four institutions embraced under the above title, for while the attendance was not so large as in 1898, it was something over 898,000. The growth of the collections is pretty evenly divided between art and science, the most important acquisition during the year being a collection of fossils obtained from the Geological Society of Glasgow.

At the monthly meeting of the British Astronomical Association, on April 25th, some statements, reported in the London *Times*, were made regarding the arrangements for observing the total solar eclipse of May 28th next. A party, of which the Rev. J. M. and Miss Bacon, and Mr. and Mrs. Nevil Maskelyne will be members, will go to Wadesboro, in North Carolina; Mr. and Mrs. E. W. Maunder, Mr. and Mrs. Crommelin, Mr. Evershed, and others, will go to Algiers; and Mr. G. F. Chambers and others to Portugal. In describing the proposed work of the expedition to the United States, Miss Bacon said that Mr. Nevil Maskelyne, assisted by Mrs. Maskelyne, would direct the telescopic kinematograph upon the corona throughout totality, and expose a long film in an ordinary kinematograph camera directed towards a chosen point of the landscape for a period commencing somewhat before and terminating somewhat after totality. The Rev. J. M. Bacon, with a telescopic camera, would photograph the inner corona as at Buxar, India, in 1898, the exposures, however, being shorter, and the development more prolonged. He would endeavor to make these exposures at definite and exact moments symmetrical with reference to mid-totality to aid in determining the relative position of sun and moon. He would also expose to the zenith for several minutes before, during, and after totality, a long sensitive film, continuously driven in a especially designed automatic instrument. By means of a kite he would compare during the eclipse the temperature at an altitude of a few hundred feet with that on the ground. Miss Bacon said that she would endeavor to photograph the outer corona and extensions, and would also repeat her former experiment of taking a 'gathering gloom' series. Special observations of shadow bands would be organized, these including a proposal to pursue them along a white road by a party of cyclists. Photographic tests would be adopted as at Buxar to compare the light of the corona with that of the full moon. Miss Bacon mentioned that the Pennsylvania Railroad authorities had kindly promised special concessions for the occasion. The United States Naval Department had intimated that the instruments would be admitted into the country free of charge and of examination; the Canadian government had granted similar facilities should the expedition pass into Canada, and the British government had done the same in respect of the return to England, so that much inconvenience and risk to photographic material and instruments generally which would otherwise be experienced would be avoided. Professor Young, the eminent solar authority, who, with his party from Princeton, had chosen the same station, Wadesboro, had offered them every assistance in his power.

The annual meeting of the members of the Royal Institution was held on May 1st. The annual report of the Committee of Visitors for the year 1899, testifying to the continued prosperity and efficient management of the Institution, was read and adopted, and the report on the Davy Faraday Research Laboratory of the Royal Institution, which accompanied it, was also read. Sixth-three new members were elected in 1899. Sixty lectures, 17 evening discourses, and two centenary commemoration lectures were delivered in 1899. The books and pamphlets presented in 1899 amounted to about 280 volumes, making, with 672 volumes (including periodicals bound) purchased by the managers, a total of 952 volumes added to the library.

The Association of Economic Entomologists will as usual hold its annual meeting in conjunction with the American Association for the Advancement of Science. It will meet at Columbia University, New York City, on June 22d and 23rd. A joint session with the Society for the Promotion of Agricultural Science will be held on the morning of June 23rd. Members of the Association are requested to send to the Secretary, Mr. A. H. Kirkland, Malden, Mass., at their earliest convenience, titles of papers that they desire to read.

THE council of the Royal Geographical Society has awarded the two Royal Medals for this year to Captain H. H. P. Deasy and Mr. James McCarthy. The Founders' Medal has been awarded to Captain Deasy for the exploring and survey work which he has accomplished in Central Asia during two expeditions lasting three years altogether. He was incessantly engaged in surveying in districts where an experienced professional surveyor would find exceptional difficulties. As tested by the Indian Survey Department, his mapping is scientifically constructed on thorough survey principles. His observations on the great extent of country traversed and on the people are of high geographical value. Mr. McCarthy is the Government Surveyor of Siam, and the Patron's Medal has been awarded to him for his great services to geographical science in exploring all parts of the Kingdom of Siam, for his laborious work during twelve years in collecting materials for a map, to form the basis of a survey system, and for his admirable map of Siam just completed. The other awards have been made as follows: The Murchison award to M. Henryk Arctowski for the valuable oceanographical and meteorological work which he performed on the Belgian Antarctic expedition; the Gill Memorial to Mr. Vaughan Cornish for his researches, extending over several years, on sea-beaches, sand-dunes and on wave-forms in water; the Back grant to Mr. Robert Codrington for his journeys in the region between Lakes Nyassa and Tanganyika, during which he removed, on behalf of the Society, the section containing the inscription from the tree under which Livingston's heart was buried; and the Cuthbert Peek grant to Mr. T. J. Alldridge for his journeys during the past ten years in the interior of Sierra Leone, during which he has done valuable geographical work.

THE 71st anniversary meeting of the Zoological Society of London was held on April 30th. The report stated that the income had been £28,879, a decrease of £328 as compared with that for 1898. The average annual receipts of the Society for the previous ten years had been £26,370. The ordinary expenditure of the Society for 1899 had amounted to £26,884, an increase of £904 over that of the previous year. Besides this a sum of £2537 had been paid and charged to extraordinary expenditure, having been devoted mainly to the construction of new buildings in the gardens and to the acquisition of a young male giraffe. After payment of the ordinary and extraordinary expenditure a balance of £1043 had been carried forward. The number of visitors to the gardens in 1889 had been 696,707, being 14,241 less than the corresponding number in 1898. The number of animals living in the Society's gardens on December 31st last was 2753, of which 821 were mammals, 1471 birds, and 461 reptiles and batrachians. Amongst the additions made during the past year 13 were specially commented upon as being of remarkable interest and in most cases new to the Society's collection. Of these by far the most noticeable objects exhibited for the first time were the splendid pair of Grévy's zebras, placed under the care of the Society by the Queen on August 14, 1899. These animals had been presented to her Majesty by the Emperor Menelek, of Abyssinia. The Council also called special attention to the young male giraffe, acquired on April 1, 1899, by purchase for £800. It was believed that this animal, together with the female purchased in 1895, formed the only pair of young giraffes now to be found in any of the zoological gardens in Europe. The meeting elected the new members of the Council and the officers for the ensuing year as follows: Lord Avebury, Mr. William Bateson, F.R.S., Sir Joseph Fayrer, F.R.S., Mr. P. Chalmers Mitchell and Mr. Oldfield Thomas to the Council in the place of the retiring members, and the Hon. Walter Rothschild, M.P., Professor George B. Howes, F.R.S., and Lieutenant-Colonel Leonard H. Irby re-elected. The Duke of Belford was re-elected President, Mr. Charles Drummond, Treasurer, and Mr. Philip Lutley Sclater, F.R.S., Secretary.

PROFESSOR FREDERICK STARR, of the University of Chicago, has returned from his tenth journey of study and investigation in Mexico. The expedition was assisted by Mrs. Frank G.

Logan, of Chicago. The chief object in view was to study the physical types of the Indians of southern Mexico. This study, begun two years ago and carried on by Professor Starr in his last two journeys, makes use of three methods of investigation—measurement, photography and plaster work. In each tribe visited, measurements are made upon one hundred men and twenty-five women—fourteen different measures being taken of each subject. Photographs are made of good types, a front and profile view being made of each. Views are also made of scenery, towns, groups, houses, occupations, etc., etc. Five persons of each tribe—notable types—are subjected to the operation of bust-making; plaster mixed with water is applied directly to the subject to form a waste-mold in which the bust is afterwards run. Five tribes were examined — the Chinantecos, Chochos, Mazatecos, Tepehuas and Totonacos. These tribes are conservative and clannish and all retain their own languages, although Spanish is understood to some extent in all their towns. Of the Tepehuas, whose linguistic relationship has been uncertain, a fair vocabulary was secured. The survival of the ancient art of beating paper from the bark of trees, was investigated among the Otomis in the mountains of the states of Hidalgo and Pueblo. The survival of the pagan practices among the Tepehuas and Otomis of the same district was somewhat studied. Several days were spent among the Tlaxcalan villages on the slopes of Mount Malintzi and many curious data were secured relative to life and customs. Other minor but interesting studies were made. It is hoped that the results of the expeditions may all be printed within the next two years. The party consisted of four persons—the director, the photographer, Louis Grabic; the modeler, Ramon Godinez, and a helper, Manuel Gonzales. The expedition involved five hundred miles of horseback riding in the most mountainous regions of the states of Oaxaca, Hidalgo and Puebla. Of the tribes visited the Chinantecos and Tepehuas were the most interesting and best known. Professor Starr hopes to complete his work next year by a study of the tribes of the Huaxteca, Chiapas and Yucatan.

At an extra meeting of the British Institution of Civil Engineers, held in April at its house in Great George-street, the eighth 'James Forrest' lecture was delivered by Sir William Preece, the subject being the 'Relations between Electricity and Engineering.' According to the London *Times* the lecture began with a statement of four fundamental principles underlying the practical applications of electricity and illustrated them with some elementary experiments. Sir William Preece pointed out that electricity was purely mechanical in its effects. It required matter to render it evident to the senses. Its transference was characterized by motion, chiefly undulatory as regards the ether, but partaking of the most known forms as regards conductors and insulators. It was, therefore, essentially a dynamical agent in the hands of the engineer to carry out his duties. The lecturer proceeded to discuss the applications of electricity under a number of heads. Among these were the purification of matter; the annihilation of space, as for instance in the telegraph, the telephone, and the use of electrical energy to move railway signals and points; the transmission of power, including the employment of electric motors to drive the machines in manufacturies; traction, including electric railways and automobile cars, the lecturer believing that the motor-car of the future will be electrical; electricity in war; and sanitation. In conclusion he said there was now a distinct line of demarcation separating the physicist from the engineer. The former dived into the unknown to discover new truths; the latter applied the known to the service of man. Research was the function of the one, utility that of the other. In the past the engineer had to rely upon himself for his facts, but the advance of modern science, the growth of technical education, the formation of laboratories, and the endowment of chairs, had changed all that. We could scarcely hope for new sources of energy to be discovered but there were some known ones as yet untouched. When the evil day arrived for our coal supplies to give out we might perhaps be able to utilize the heat of the sun and the tides of the ocean. There was, however, a vast illimitable store of energy not only in the rotation of the earth upon its axis, but in the eternal heat of this globe itself. As we descended below the surface the temperature became higher and higher, and it ought not to be difficult to reach such temperatures that by thermo-electric appliances we might convert the lost energy of the earth's interior into some useful electric form.

WE learn from the *British Medical Journal* that Mr. A. L. Jones, whose name has for some time been associated with the Liverpool School of Tropical Medicine, has set on foot a scheme for assisting natives of tropical colonies to go to Liverpool to study medicine and obtain a qualification to practice. The African Steamship Company has consented to convey to and from England any natives of Africa who desire to avail themselves of this arrangement at a greatly reduced cost, and it is calculated that it will be possible for them to fulfill the five years' curriculum and obtain their qualification to practice at a cost of about £600, including the passage money and the expenses of living. Messrs. Elder, Dempster and Co. have addressed a circular to the respective Governors of the West African Colonies, asking them to bring the scheme to the notice of schoolmasters and others in touch with secondary education, and seeking for information as to how far the education in the colony is organized to admit of natives being prepared for one of the preliminary examinations recognized by the General Medical Council. It is intended to include West Indian natives in the scheme.

IN presenting Mr. Charles Hose for the honorary degree of Doctor of Science at Cambridge University, the Public Orator, Dr. Sandys, stated, according to the London *Times*, that for the last ten years, Mr. Hose had been the Resident of the Baram district in Borneo, in that part of the island which was under the rule of Sir Charles Brooks, Rajah of Sarawak. As Resident, Mr. Hose had, in a masterly manner, put an end to an inveterate blood feud between two hostile tribes, and had diverted their energies from the pursuits of war by the peaceful institution of an inter-tribal boat race. At the sacrifices connected with the ratification of the treaty of peace, he had proved himself a most skillful *haruspex* by finding in the flesh of the victims omens of peace and prosperity to all the tribes of the district; while in his scientific knowledge of the birds of Borneo, he had also proved himself an *augur et auspex admirabilis.* It was under his auspices that the museums of Switzerland, Holland, Germany, France, and England had successively been supplied with many important specimens of the birds and mammals of Borneo; while his own researches had thrown a new light on the zoology, the anthropology, and the geography of the island. He had thus extended the bounds of science near the confines of the British Empire. In recognition of the value of his scientific work, he had received distinctions from the Royal Geographical Society and from other bodies, and among the honors he had received from the nations of Europe was the not inappropriate title of 'Knight of the White Falcon' of Sachs-Weimar. Lastly, for more than ten years he had been a constant and generous benefactor to the Cambridge Museums of Zoology, Anatomy, and Archæology; and, only two years ago, he had given the most cordial welcome and the most valuable assistance to the Cambridge Anthropological Expedition to New Guinea and Borneo.

THE Friday evening discourse at the Royal Institution was given on April 13th by Lord Kelvin, whose subject was 'Nineteenth Century Clouds over the Dynamical Theory of Heat and Light.' Sir Frederick Bramwell was in the chair, and among those present were Sir George Stokes, Sir Andrew Noble, Sir Frederick Abel, Sir William Crookes, Sir J. Wolfe-Barry and Sir James Crichton-Browne. Lord Kelvin said, according to the London *Times*, that there were only two clouds to obscure the beauty and clearness of the dynamical theory which might be briefly expressed by saying that heat and light were modes of motion. The first came into existence with the undulatory theory of light, and was dealt with by Fresnel and by Dr. Thomas Young; it involved the question, how could the earth move through an elastic solid, such as the luminiferous ether was supposed to be, far more easily and freely than the 'wind through a grove of trees'? This cloud hung heavy and undispersed. Some years ago Michelson made a beautiful experiment to discover whether the ether passed freely through the earth, and *vice versa.* Lord Kelvin still hoped that it did, but from the results of that experiment, which proved that it did not, he could see no way of escape. The second cloud over the dynamical theory was the Maxwell-Boltzmann doctrine of the partition of energy. Here the outlook was less sombre. He held that mathematics had not proved the doctrine and that the doctrine was not true. Still he did not know any one but himself that attacked it, and his own views had been attacked by Poincaré, Lord Rayleigh, and other distinguished mathematicians, though none of his assailants had proved the proposition. Lord Kelvin proceeded to give some illustrations of the doctrine, and emphasized the labor and difficulty of putting it to experimental tests. Its mathematical consequences indeed sometimes appeared to be contrary to common sense, but that was not conclusive, for mathematics must never be judged by common sense. Still, within the last few months he had worked out a large number of cases and had obtained results that did not agree with the doctrine. The simple way, therefore, to destroy this second cloud on the dynamical theory was to drop the destructive general conclusion of the Maxwell-Boltzmann distribution. In conclusion, Lord Kelvin brought forward some considerations respecting the structure of the atom and the nature of the ether, regarded as a true imponderable outside the law of universal gravitation.

UNIVERSITY AND EDUCATIONAL NEWS.

The endowment fund committee of Brown University has issued a statement of the condition of the fund. The effort to raise $1,000,000 in order to secure the conditional gift of $250,000 of John D. Rockefeller resulted in securing in cash, legacies and pledges $700,000. The remaining $300,000 must be pledged by commencement in order to make Mr. Rockefeller's gift available.

Yale University has purchased land opposite the State Hospital for its medical school.

The Cambridge University General Board proposes to establish a lectureship in ethnology for Dr. Haddon and a lectureship in bacteriology and preventive medicine for Dr. Nuttall. New lectureships in experimental physics and agricultural chemistry are also recommended.

The *Educational Times* states that active steps are now being taken for the establishlishment of Commercial Universities at Marseilles, Hamburg, and Berlin. The advance of commercial education is very marked in Japan. The establishment of an Imperial High School of Commerce at Tokio has had such satisfactory results that a like school is now in contemplation for Osaka, and the creation of a degree of Doctor of Commercial Science is under discussion. There are four grades of commercial schools in the Japanese Empire. In schools of the second and third grades, designed for youths who have completed their fourteenth year and will devote three to five years to special study, amongst the subjects taken up we find ethics, Japanese, Chinese, and English (or other foreign language), mathematics, geography, history, economics, commercial legislation, bookkeeping, commodities, principles of commerce, business practice, and gymnastics, together occupying respectively thirty and thirty-three hours a week, with a five years' course. In the third grade correspondence and commercial arithmetic figure as additional subjects, and the whole course is more extensive.

Edwin A. Alderman, for several years president of the University of North Carolina, has accepted the presidency of Tulane University, New Orleans.

Dr. Charles W. Green of Leland Stanford University, has been elected to the professorship of physiology in the University of Missouri. Dr. Green is a graduate of Leland Stanford, '92, and for the last two years has been assistant professor of physiology at that University.

Herbert G. Lord, A.M. (Amherst), has been appointed professor of philosophy in Columbia University. He will have charge of the introductory collegiate courses.

Teachers College, Columbia University, has awarded four fellowships as follows: Frank P. Bachman, A.B. (Chicago); Edwin C. Broome, Ph.B. (Brown); Rufus C. Bently, A.B. (Nebraska); John W. Hall, A.B. (Colorado).

SCIENCE

Friday, May 25, 1900.

CONTENTS:

SHOULD LATIN AND GREEK BE REQUIRED FOR THE DEGREE OF BACHELOR OF ARTS?

The removal of Latin from the curriculum required for A. B. by another prominent university has re-opened discussion respecting the relative worth of classical and other studies. The discussion is conducted much in the same manner as of old and disputants on both sides frequently show irritation when the opposing opinion is expressed. They seem to regard the matter as so thoroughly settled that all doubts can be disposed of by a wave of the hand. But the matters involved deserve very different treatment from this. There must be something worth considering on both sides, otherwise intelligent men would not be ranged in opposing camps. The writer will endeaver to present one side of the case.

One point should be noted at the outset. It must be evident to those who have followed the discussion during late years that the contestants are not equally competent to render judgment. Most of those who resist encroachment upon territory, held so long by the older system, and who deny that inductive sciences can be utilized as culture studies are unfamiliar with science and cannot distinguish between pure and applied science. Their reading has been determined by their college training, or their studies have been confined within somewhat narrow limits by professional surroundings. Their knowledge of chemistry and physics is bounded by the curriculum of thirty or more years ago in the larger colleges or by that of some of the younger institutions with limited resources; while their knowledge of biology, geology and modern psychology has been derived from magazine articles, popular summaries or from controversial works of not wholly friendly character.

American workers in pure science, who have passed middle age were trained, with few exceptions, in the studies of the old curriculum, so that they understand thoroughly its nature and its advantages. But the exigencies of their work have compelled them to recognize the deficiencies also. The great majority of those laboring in pure science have a working knowledge of French, German, and Italian and many add Spanish and Russian; some require in addition a good knowledge of the oriental languages as well as of numerous dialects —in every case a knowledge much more exact than the knowledge of Greek and Latin possessed by the ordinary college graduate; and all of this merely as preparation for their work. Such study necessarily brings men into touch with a great range of knowledge, so that, especially among naturalists, many are well read in various branches of philosophy and almost all have a broad acquaintance with literature. These are the men who assert deliberately that the older system of education is a survival of conditions which men have outgrown and that it is no longer fitted to our needs.

In one sense, education, as training, is an end in itself, being a course in mental gymnastics; but in the true sense it is far more, embracing not merely mental training but also the imparting of knowledge.

In another place, the writer likened the college course to emery used in polishing metal and held that, as one has no concern for the emery after the metal has been polished, so, if the youth be developed, it matters little whether or not his college studies disappear from memory. But this is a narrow view, regarding mere training as the single end, not considering that this strengthening, developing process consumes the years when the power of acquiring and that of retention are most efficient. Those years ought not to be expended in training to the exclusion of learning. Youth in America is shorter now than formerly; manhood's responsibilities come earlier and are heavier; one cannot ignore the utilitarian side of education—utilitarian, not in the sense of dollars and cents but in that of preparing the man for usefulness. There should be more than mere robustness to show for the labor of the early years, some capital should be accumulated with which to utilize the robustness.

Study of classical tongues retained its very prominent place in college curricula long after necessity for it disappeared. Until little more than one hundred years ago, classical languages were studied for use— the study was as purely utilitarian in purpose as is that of the Calculus to-day. Latin, as the language of the mediæval church, was the language of educated men until the latter part of the eighteenth century; university lectures were delivered in Latin; scientific, theological and philosophical works were written in it. At the revival of learning, the sources of knowledge were classical and early Christian writers: to reach them, acquaintance with Greek and Latin was essential; those tongues were learned by students at that time as anatomy is learned by the medical student of our time and for the same reason. There were but two learned professions, Law and Theology, with Medicine as a coming third. Education was for the few, to enable them to enter a profession, not to develop them, not to render them useful. Educated men could not touch commerce—that was degradation. But education now is for all, for the poor as for the rich, for the merchant as for the professional man; we recognize that the professional man ranks no higher intellectually than does the financier, whether the latter deal in money or in goods. This absolute reversal of conditions cannot be ignored in the discussion.

When men threw off the bonds of the mediæval church, the study of things replaced that of words; men discovered themselves and the great world about them. As knowledge increased, respect for the dicta of ancient writers decreased; Latin and Greek fell into disuse and at length necessity for acquaintance with them disappeared. But the curricula had become hoary with age; change meant revolution; the universities were controlled by men who knew no other training and the prominent instructors in almost all branches belonged to the clerical profession. Those investigating material things were spoken of disdainfully; even those studying the physical portion of man received little respect from those who studied his mental and spiritual portion—their work was referred to patronizingly as requiring less intellectual power than that of their critics—a reflection not wholly unknown in our time, for there are still those who appear to think that familiarity with material things unfits a man for taking the higher flights of philosophical reasoning. There may be something in this reflection, for a knowledge of facts cannot fail to fetter the wings of a philosopher of the old type.

When classical study ceased to be necessary from the utilitarian standpoint, those entrusted with educational work discovered that it was still necessary from an educational standpoint. Verily necessity is the mother of invention. Necessity increased with years and for the last half century men have been seeking excuses for retention of compulsory classical study. They have succeeded in convincing those who know little about either classics or science that without such a smattering of the classics as the college man usually receives, no one can be regarded as educated.

The change in purpose brought about a change in the teaching, so that classical instruction, as commonly conducted in secondary schools, leads a youth along an investigation of grammatical principles. The great majority of young men, who enter college after four to six years of preparation, find themselves so burdened by lexicon work that too many of them seek relief in the convenient 'Bohn.' Acquisition of the vocabulary seems to be less important than mastery of nice points in syntax. An eminent instructor in Latin told the writer that in marking students he laid little stress on translation, as a 'Bohn' is always available; his grading was based on proficiency in prose and quantity which had to be studied. That a large proportion of Bachelors, after ten years of study, cannot read their diplomas without resort to a lexicon causes no surprise to them or to their instructors. They had not been attempting to acquire either Latin or Greek, but they had been utilizing classical words and idioms in studying the principles of grammar. True it is, that this statement is not of universal application; there are exceptions among both instructors and students and, owing to the demand that there be something tangible to show for the labor of years, the number is increasing; but the fact remains that the conditions as described are those which prevail; and they have much to do with the notion that the study of classical languages is much more difficult than that of other languages.

But one asks, suppose that the young man has acquired an accurate knowledge of, let us say, Latin, that he can read, write and speak it, has he gained nothing? He has gained much, he has learned accuracy in expression; a certain discrimination in the use of terms; he has cultivated his memory; he has become acquainted with the tongue in which men of Rome expressed their thoughts; in which many theologians of the early centuries expressed their conceptions of what Christianity ought to be; in which theologians of later centuries expressed their conceptions and misconceptions of what the Fathers wrote; the language of educated men until a little more than one hundred years ago. Thus he has acquired, first, a sharpening of certain faculties and, secondly, the means which give direct access to a great literature representing in time more than two milleniums preceding our century.

This much he has acquired and it certainly is a great deal. Those who defend the necessity for classical training assert that he has acquired much more if he be an English-speaking student. It is said that one has a better understanding of his own tongue if he have a good knowledge of the classics, since so much of our language is derived from the Greek and Latin. Shakespeare, we are told, enriched our vocabulary by the addition of not less than three thousand words.

Much is made of this, but one may doubt the importance of the reasoning. Words are available when they become identified with things either material or abstract, so that one's ability to use them with precision depends upon the exactness of the identification. The question of their origin does not enter into the matter. Indeed, one too fully imbued with the signification of parent-words may employ derived words in senses at variance with accepted significations. If there be any force in the argument, it would apply rather to a course in Anglo-Saxon or in the language of the Authorized Version, if the object be to cultivate a direct style. That Shakespeare's works enriched the English vocabulary admits of no doubt; but if Shakespeare wrote his plays, the argument gains little strength by reference to him, for, according to Ben Jonson, he knew 'little Latin and less Greek.' In any event, however, this is a matter of no importance. The suggestion that our language is in urgent need of further enrichment can hardly commend itself as wise in view of the fact that the lexicons already boast of approximately three hundred thousand words, while the vocabulary of the metropolitan newspaper does not exceed three thousand and that of great writers rarely equals ten thousand.

But conceding all that has been conceded so willingly because true, the query persistently comes: Is the profit in due proportion to the expenditure in time and labor? Might not the mental discipline be acquired equally well by the use of other languages, which would open a wider field of knowledge and render the man more useful to himself and to his fellows?

The modernized courses pay too little attention to instruction in the use of language. The literary courses are better than the older types in that they do not exclude the English language and proper training in that direction is not far away; but the defect is still too conspicuous, especially in the scientific courses. Laboratory work leads to exactness in method; field-work gives precision in observation and comparison; scientific training, in general, strengthens the logical powers and gives precision in thinking; but none of them gives precision in expression. As in theological seminaries, too often, preparation for preaching is neglected on the principle that if a man has anything to say he will find no difficulty in saying it, so the study of language as a means of expressing one's thoughts has been neglected in scientific training. Nevertheless, one cannot fail to recognize that the writings of scientific men compare, at least, favorably with the writings of those who have had the great advantage of classical training, that is to say, of the average clergymen and lawyer, those who plead so urgently for retention of the system from which they have received such abundant profit. Brilliant rhetoricians cannot be taken as examples of what the training can do—in the intellectual as in the vegetable world, the average of the fruitage, not the choicest selections, must be taken as type of the product. And one must not forget that the soil in which seed is planted has much to do with the crop.

But the remedy for this defect in modern training is very simple, and its application involves no material change in plan.

The advantages derived from education according to the old system do not come from the study of Latin and Greek any more than they would come from the study of French, Hebrew or any other language. The results are due to the method, not in any sense to the particular language employed. One may say, better, that the result is due rather to skill in applying the method, for classical teaching is very different to-day from that of the older day, when pupils were plunged *in medias res* at the outset. The Arnoldian method is not so far removed from the Ollendorfian as a casual observer might imagine. Why then do we hear the constant claim for the advantage of classical teaching?

The reason is found in conditions still existing in our secondary schools. There, the ablest teachers have always been those in classics, though increasing requirements for college entrance have led in many instances to the selection of strong men for mathematics. Until very recently, the study of English has been perfunctory, while, for the most part, French and German have been taught by 'natives' because they alone can give the 'proper pronunciation.' But those excellent men, though efficient teachers for pupils willing to learn, too often fail as disciplinarians and have to pay more attention to quieting disorder than to imparting knowledge. Here must be made the change needed to remedy the defect in our modern system. Men must be employed, who can teach the modern languages as Latin and Greek were taught seventy-five years ago, when the pupil acquired not merely a fairly accurate knowledge of grammatical principles, but also the language itself. Our colleges must demand more thorough preparation in modern languages—in other words, the transformation which college courses have undergone must reach into the secondary schools. Able men occupy modern language chairs in colleges; able teachers must be found to prepare students.

But some may feel that while a modern language course may be as useful mental training as is a classical course, still there may be room for doubt whether or not he has gained equal preparation for his life's work.

If the end to be attained by classical study, beyond mere discipline, is the ability to read the works of those who wrote in classical languages, surely the labor has been that of supererogation, for practically all that is good in the ancient languages, whether theological or legal or literary, has been done into English after a fashion many times better than that of the amateur—and the reading in English will be vastly more profitable than that in the original, for one's contemplation of lofty sentiments or useful matter is not likely to be interrupted by struggles with difficult construction. This argument is treated with such contempt by advocates of elaborate classical study that one is inclined to regard it as unanswerable. It is said, however, that the true meaning of an author cannot be ascertained from a translation, the work must be read in the original—which is equivalent to saying that, to most of us, works in a foreign language, especially those in a dead language, must remain sealed books. No man can acquire a knowledge of a dead language, so exact as to enable him to think in it, without expending so much labor as to leave time for little else, so that to most of us a conception of what the writers meant must come through translation.

But we may dismiss this last argument, for it is purely academic and has no reference to the actual condition. It is not pretended that the ordinary college graduate knows enough to make the reading of Latin or Greek authors a delight in hours of relaxation from the burdens of everyday life. Long ago, Latin text-books were abandoned in theological seminaries, not so much because the theology was antiquated as because the students were so burdened by translation that neither time nor energy remained for study of the matter.

But granting all that is claimed, the question still recurs, is the game worth the candle? Is access to classical authors in the original or even in translation a matter of such importance to the average man as to justify the expenditure of the most important years of his life? One cannot avoid expressing some doubts respecting this. Unquestionably, the men of classical Greece and Rome were, in some instances, men of towering intellect; those who worship at the classical shrine demand that we point out in modern times the equals of Aristotle, Homer, Thucydides, Plato, Seneca, Vergil, Tacitus, Horace, Quintilian and half a score of others. Where in modern literature, we are asked, can one find such elevating sentiments, such ennobling philosophy, such brilliant rhetoric? One may reply that perspective has much to do with this type of ancestor worship, that a score or even two scores of names gathered from more than a millenium of antiquity could easily be matched by a score of names gathered from the five centuries preceding our own. Even our nineteenth century, whose materialism grieves so many hearts, does not pale in comparison with the golden period of either Greece or Rome. Men do not stand out pre-eminently now as they did centuries ago, for the field of knowledge is so wide and the laborers so numerous that one may gain eminence only with great difficulty in even a very contracted portion. Pre-eminent in his own area, he may be utterly unknown to workers elsewhere. It is probable that the ablest astronomer in America cannot name the most eminent ten chemists in the world and, in like manner, that the ablest chemist cannot name the most eminent ten astronomers. It is equally probable that no eminent philosopher or historian in this country can name the ten Americans who have been pre-eminent in the several branches of science during the last fifty years. If Aristotle were living now, he would be an eminent professor of philosophy in some university, much respected by philosophers elsewhere, but unknown outside of his immediate circle, unless, like Herbert Spencer, he should undertake problems of broad type, in which case, no doubt, he would be as little read and as much misrepresented as Spencer himself.

Of course, one risks much in venturing to question the over-towering grandeur of the ancient writers, for their names have been enshrined so long that doubts respecting their superiority appear as sacrilegious as were Galileo's doubts respecting the Ptolemaic system. But the fact remains, that the commonly accepted verdict in favor of the ancient writers is not that of our day—it was pronounced at the revival of learning amid the shadows of the receding dark ages and it has become a tradition in seats of learning to be guarded carefully as a pillar of the intellectual universe.

But the student, who has a thorough knowledge of French and German as well as of his own language, still has access through translations to the thoughts of antiquity, while he has vastly more. He has access to the best thoughts of modern times, to the works of authors in all branches of knowledge during this, the age not only of greatest intellectual activity but also of the most accurate investigation. If he be a professional man, he can keep himself abreast with advance; if he have turned aside to commerce, he finds himself equipped for the broader fields; in any case without early training in those languages, he is crippled and is compelled to learn them amid the pressure of other duties. Those languages he must know—without them, he cannot gain admission to graduate schools of our stronger universities. They are as essential as was Latin a century ago and for the same reason—they are, so to speak the tools of trade. In philosophy, law, theology and the various branches of science, a man is at more than serious disadvantage without them.

In all this, there is no denial that a knowledge of Greek and Latin is useful; but that is wholly aside from the issue, which is, whether the gains from the study of classical languages are such as to justify the demand that it retain the very prominent place in the curriculum. The utility of some acquaintance with Latin and Greek is beyond dispute; naturalists employ terms derived from those languages; astronomers and chemists make heavy drafts on mythology, while relics of old practice in law and medicine remain embalmed in Latin terms and phrases. But the knowledge of Greek and Latin necessary to the physician, clergyman or lawyer is not great in quantity; if it were, most of the college graduates who have taken up those professions would feel themselves sadly handicapped. Indeed, a 'smattering' is all that very many energetic writers demand.

Elementary courses in Hebrew, Arabic, Assyrian, Italian and Spanish are given in all of our larger institutions and, in many, the opportunity is still afforded for the beginner in French and German. Similar courses, as options, ought to be offered in Latin and Greek, planned to give a good knowledge of the vocabulary and to acquaint the student with that something, which we are accustomed to call the 'genius' of the language. A faithful student, with an object in view, should be able in two years to read, with comparative ease, any ordinary work in either of those languages. Certainly, no one will assert that Latin and Greek are more difficult than German or that the idioms are more perplexing than those of Spanish. Scientific men understand this, for there are doubtless few who have not been compelled to acquire at short notice a working knowledge of an additional language in order to prosecute an investigation already begun.

When our college curricula shall have been properly adjusted, the graduate will have received the polish obtained by study of language and literature, the logical mode of thought obtained by study of mathematics, the knowledge, strength and judicial tendency obtained by study of the inductive sciences; while in addition, he will have the means to utilize his gains in the profession or calling which has been in view during the later years of his college life.

JOHN J. STEVENSON.

THE BULLETIN OF THE AMERICAN MUSEUM OF NATURAL HISTORY.

IN 1881 Professor R. P. Whitfield saw that the scientific needs of this Museum, its reputation amongst kindred institutions in the world, and its proper recognition of its natural responsibility to the world of science, as well as the obvious advantages to itself, demanded that some scientific publication should be begun. Publications were commonly considered invariable concomitants of Museum life. The Museum of Comparative Zoology, under Louis Agassiz, began its important series of Bulletins in 1863, and later enlarged the work of investigation by instituting the Memoirs, begun in 1864. The Bulletins were largely at first devoted to systematic work but this was soon gradually invaded and partially displaced by biological studies and such admirable geological and physiographic papers as R. T. Hill's Geology and Physical Geography of Jamaica. A. Agassiz's study of the Fiji Islands and the Three Voyages of the Blake appeared.

The Museum of Comparative Zoology boasted of an extraordinary group of students, and the inception of a bulletin or some other form of publication was inevitable. Here A. E. Verrill, S. H. Scudder, J. A. Allen, Jeffries Wyman, Wm. Stimpson, A. S. Packard, J. G. Anthony, Alpheus Hyatt, W. H. Niles, A. Agassiz, F. W. Putnam, O. St. John, C. F. Hartt, L. F. de Pourtales, Theodore Lyman, P. R. Uhler, U. S. Shaler, Horace Mann, W. H. Dall, A. S. Bickmore were likely, from their superabundant enthusiasm and industry, as well as the unflagging zeal of their leader Louis Agassiz, soon to demand a printed page for their results in various fields of natural science. It is in much more recent years that these splendid publications have been continued on a biological line, by Folsom, Bouvier and Fischer, Mayer, and A. Agassiz, Hamaker, Galloway, Bancroft, Parker, Gerould, Wilcox, Vennings, Meyer, and Neal.

Yet, under the most favorable conditions for the supply of material, the early volumes of the Museum of Comparative Zoology did not equal in size the first Bulletins of the American Museum of Natural History.

The Memoirs of the Museum of Comparative Zoology embodied more elaborate contributions to science in the form of quarto volumes, in which such notable studies as Allman's Hydroids, Agassiz's Echini and Acalephs, Faxon's Stalk-eyed Crustacea appeared.

The Peabody Museum of American Archæology and Ethnology publish Annual Reports embracing some scientific information, miscellaneous papers, and Memoirs. The Peabody Museum of Yale University publishes Memoirs, the Field Museum of Chicago engages in the publication of papers in its various departments. In New York, the Reports of the Regents of the University of the State of New York, on the condition of the State Cabinet of Natural History, had been long established. This last important series had been the depository of scientific papers and afforded an outlet for Professor Hall's paleontological studies which otherwise would have suffered partial suppression. These Reports have been succeeded by the Reports of the Museums, filled with useful and often elaborateand comprehensive treatises on questions in State Geology, Paleontology and Botany.

The Smithsonian Institution and the National Museum have been prolific sources of published material, and the Museums in Europe have issued numerous studies and periodical papers.

It would indeed be very obvious to any thoughtful mind that the Museum could not long maintain a self-respecting attitude towards the world of science, nor bring itself into correlation with its own expectations if it did not have a scientific publication. Besides, there were substantial benefits of another sort to be secured. The Bulletin or whatever other publication was finally decided upon would be the means of bringing the Museum into correspondence with societies, institutes, museums, lyceums, throughout the world, with whom a profitable literary exchange could be at once instituted. The Library would be in this way fed and increased. It is difficult, or impossible, without a very considerable expenditure of money to obtain these publications, but in the wide fraternity of scientific workers, their efforts at different stations to solve scientific questions, is mutually appreciated and instantly required. Thus a scientific commerce with the rest of the world would become established. Then it formed naturally the only way in which the Museum's own possessions could be presented to the scientific world, while the inevitable development of expeditions in connection with the institution could only find, by such an avenue of communication, general recognition. A letter from Professor R. P. Whitfield to President Jesup was written urging the usefulness of a scientific publication.

The President accepted the suggestion, and a small appropriation was made for printing some papers, then in Professor Whitfield's hand. At first it was deemed wise that all papers should be submitted to one or two scientific men outside of the Museum who should determine the eligibility of the paper for reproduction. This plan was followed for a short time, but was abandoned as inconvenient and unnecessary. The Curators were made the judges of the character of their own papers, and, as they expected criticism upon the broad impartial stage of the general and special scientific world, they were led to exercise great caution in their judgment. Finally a 'Committee on Publication' was formed by the President, of which officially all curators were members. Their deliberations determine to-day the nature, contents, extent of, and all details connected with the Museum publications. Appropriations of money for this work come under the control of the President of the Executive Committee. With the creation of new departments, new curators, and the extraordinary accession of material from expeditions, the number of papers pressing for publication increased, and a subsidiary outlet for this overflow was provided in scientific journals, a relief now used by the department of Archæology particularly. A restriction upon this scientific matter had early been instituted by limiting it to museum material, so that, except incidentally, all abstract discussions and scientific polemics, were excluded.

Besides the scientific publications there had been always printed by the Museum, the Annual Report, and occasional Guides to various departments, as the Guide to Invertebrate Paleontology, Guides to Birds and Mammals, and List of Birds found within 50 miles of New York City.

The Guides disappeared as failing in some ways to meet popular needs, but the Annual Reports have increased in size steadily, and are now illustrated reports on the condition of the various departments of the Museum in general, its aims, resources, and needs, being partially composed from the quarterly and annual reqorts repuired from the Curators, giving the condition, prospects, and requirements of their various interests.

It was an interesting coincidence that the appearance of the Bulletin was almost synchronous with the beginnings of the Department of Public Instruction. These two features certainly quite effectively give the Museum an educational character, and, in the two fields of popular instruction and scientific work, place its guarantee of good faith in its first pretensions, in the hands of the public.

In giving any epitomization of the contents of the Bulletins the most direct and succinct treatment will be a separation of their contents under the general classes of subjects represented in the various departments of the Museum, as Paleontology (vertebrate and invertebrate), Ornithology and Mammalogy, Mineralogy and Geology, Conchology, Entomology, Invertebrate Zoology, Ethnology, Archæology, and then a very brief analysis of their contents, under the head of systematic work, investigation, and description of new species. The present number of volumes of the Bulletin is twelve.

The accompanying table shows the distribution of papers in the general departments of science enumerated in the first column. The Memoirs so far published embrace two volumes, as yet incomplete; Vol. I., parts 1, 2, contain papers on Invertebrate Paleontology, parts 3, 4 and 5 on Vertebrate Paleontology; Vol. II., parts 1, 2, contain papers on Ethnology, part 3 on Archæology.

Bulletin-Series; Analysis of Contents.

(Papers Published.)

	1	2	3	4	5	6	7	8	9	10	11	12
Ethnology									1	2		2
Archæology								3	1			
Mammalogy	2	5	15	3	12	9	5	5	9	5		7
Ornithology	2	10	5	6	2	1	1	4	2	1		3
Ichthyology and Herpetology	2								1	2		
Entomology				6	3	4	1	2	3	2		2
Invertebrate Zoology										2		1
Conchology	1											
Paleontology (vertebrates)		1	1	3	5	3	4	3	3	6		3
Paleontology (invertebrates)	10	4	3			1		2	4			
Geology	1		1					1				2
Mineralogy							1	1				1
Catalogue											1	
Pages	348	307	441	371	341	368	318	304	375	464		326
Plates	35	13	11	16	8	11	11	14	38	25		14
Figs. and cuts	8	2	14	29	18	24	39	36	144	76		109

A glance at this table shows the very evenly maintained interest and activity in Mammalogy and Ornithology, a less but noticeable industry in vertebrate and invertebrate Paleontology and Entomology, and the very imperfectly established attention to Geology, Mineralogy, Vertebrate and invetebrate Zoology, the absence of original work in Conchology, and the late contributions in Ethnology and Archæology.

When this series of scientific papers is examined by a less superficial and statistical method, the comparative importance of the papers becomes more obvious, and the deceptive results apparent of seeking equalization by enumeration simply. A paper of the far-reaching and suggestive character of Dr. Wortman's treatise on the Ganodonta for instance while counting only as one paper, in labor and intrinsic excellence might justly over-balance a number of less studious or incisive contributions. So perhaps might be instanced Dr. Matthews' paper on the 'Revision of the Puerco Fauna,' Dr. Boas' 'Decorative Art of the Indians of the North Pacific Coast,' Dr. Allen's 'Alleged Changes of Color in the Feathers of Birds without Moulting,' Professor Whitfield's 'Fossils of Lake Champlain,' and Professor Osborn's papers on fossil mammalia. The character of the articles throughout is thoroughly in keeping with the scientific aims of the institution, but they also of necessity vary in their relative value.

In the three lines of systematic work, description of new species, and investigation, the two first largely preoccupy the attention of the writers, as might be expected. The first issues of the Bulletin were made at a time when the obvious material at hand was the specimens of the cabinets, and while they afforded theses on taxonomy, nomenclature, revision or description of species, it was not until the new phase of activity introduced by expeditions, allowed a broader range, and actually made investigation imperative, that this last became fully recognized. Amongst the first contributions in this direction was the publication of the interesting results of Professors Seely and Brainard's examination of the eastern shores of Lake Champlain.

These geologists discovered that the Calciferous and Chazy formations have here an unexpected development, and that there aggregate thickness ranges to near 2,500 feet, while a great group of fossil species forms a new and interesting fauna. The descriptions of the fossils from this region which deceived Professor Whitfield by their close resemblance to the Birdseye Limestone, formed perhaps the most important paper in the first volume of the Bulletin. In this paper Professor Whitfield described 33 new species and instituted two new genera of invertebrates, while there was shown to be a lower extension of the Trenton limestone than had been anticipated, mingling its characters with forms having a cambro-silurian expression.

Professors Brainard and Seely followed later in the Bulletin of the Geological Society with a careful analysis of the geological relations of these beds and confessed their own astonishment at the new views they felt compelled to present.

Professor Whitfield also in this first volume of the Museum Bulletin enlarged his important suggestion, previously made in the *American Journal of Science*, that the group of fossils which had been regarded as vegetable in their origin, viz, *Dictyophyton*, *Uphantænia*, *Cyathophycus* etc., were truly spongoid bodies and allied to the *Euplectella* or glass sponge of modern seas, a view coincided in by Dr. J. W. Dawson.

Professor Whitfield also in this volume of the Bulletin described a 'Fossil Scorpion from the Silurian rocks of America,' the earliest land animal described from American rocks, and of great interest as synchronous with similar discoveries in Sweden and Scotland. It naturally formed a new genus and was also made the type of a new family. Besides these papers a number of others prepared by Professor Whitfield were purely descriptive. In fact the character and value of the first volume of the Bulletin were determined by its geological and paleontological papers, as the other departments in the museum had then scarcely assumed a scientific direction, and their contributions were few and tentative. Amongst these however, Dr. J. A. Allen's paper on 'The Masked Bob-white of Arizona and its Allies' easily ranked first.

In the second volume of the Bulletin a rapid increase of the papers on contemporaneous Natural History is observed, outranking all other contributions. The rare West Indian Seal (*Monachus tropicalis* Gray) was described by Dr. Allen. This remarkable animal had previously only been known to naturalists by an 'imperfect skin, without skull' in the British Museum, and another specimen taken in 1883. In December, 1886, "Mr. Henry L. Ward, of Rochester, son of Professor Henry A. Ward, visited the three little keys off the northwest coast of Yucatan known as The Triangles, for the express purpose of securing specimens of this rare animal."

The Seals were found in considerable numbers but the circumstances were somewhat unfavorable. Forty-nine seals were killed, forty-two of which were taken away, but one of them was lost. From these materials Dr. Allen formed his paper. Papers on Collections of Birds from Ecuador, Bolivia, the Maximilian Types of S. A. Birds, new species, and seasonal variation in *Elainea* by Dr. Allen and Mr. Chapman with further papers on mammals, furnished the bulk of contributions to this second volume of the Bulletin.

Professor Whitfield published further observations on the Calciferous Sandrock from Lake Champlain, and a description of a fossil barnacle from the Marcellus Shale which challenged attention from the hitherto unrecorded early age for a cirripede in American paleozoics.

The results of expeditions now rapidly appear in the succeeding bulletins, and collections made in Texas, British Columbia, West Indies, Mexico, Costa Rica, furnished many papers on birds and mammals for the third bulletin. Dr. E. A. Mearns contributed four papers on small American mammals, and a few further observations by Professor Whitfield completed this volume. Perhaps the most notable paper in this series was that of Dr. Allen on a 'Review of some of the North American Ground Squirrels of the Genus *Tamias*.'

In volume four of the Bulletin, completed in 1892, Entomology first makes its appearance amongst these papers, a series increased and continued by Mr. Beutenmüller in all succeeding publications of the Museum. These papers were confined to lists, for the most part, of collections in the Museum, and were occasioned largely by the new additions of specimens, secured in the Edwards and Elliott cabinets of insects. One paper of great usefulness was that devoted to Gall-producing Insects within 50 miles of New York City. Vertebrate Paleontology now assumed importance in the Museum, and the wonderful results of the expeditions to the west led to the important papers, in this subject, by Osborn, Wortman, and Matthews, a series developing in later issues to extraordinary interest and permanent importance. In this volume the analysis of *Protoceras* by Professor Osborn and Dr. Wortman was of especial value; Earle's Revision of Coryphodon was a helpful systematic study.

Dr. Allen and Mr. Chapman continued their systematic and descriptive work in ornithology and mammalogy, in which the former's 'Geographical Distribution of North American Mammals' furnished a splendid contribution to zoo-geography and involved a large review of observations, with an authoritative demarcation of the districts and faunas in the mammalian occupation of North America.

Volume fifth of the Bulletin contains systematic and descriptive articles and is conspicuously attractive, though perhaps falling somewhat below its predecessors in interest. Wortman's and Earle's paper on the 'Ancestors of the Tapir' strikes a strong note of original study, and Osborn and Wortman's establishment of a new genus *Artionyx* opened up some new lines of vertebrate relationship. Beutenmüller's 'Descriptive Catalogue of Butterflies found within fifty miles of New York City,' was distinctly useful.

Volume sixth continued the interest which was awakened in volume five. The papers were valuable and involved very diverse topics. The scientific treatment in a few was typical, as in Dr. Wortman's paper on the 'Osteology of *Patriofelis*.'

The articles of this sixth volume formed a very interesting series. A noticeable feature of the Bulletin was supplied by the Department of Vertebrate Paleontology and three papers of importance issued from the pens of Professor Osborn and Dr. Wortman. Amongst these the discussion of the osteology and critical position of *Patriofelis* challenged attention. It revealed an animal living in the later Eocene of aquatic or semi-aquatic habits, provided with powerful jaws, robust teeth, and probably depending on turtles for its subsistence. The Bridger basin swarmed with turtles, and coprolites, possibly referable to this animal, have been found along its margin, in which turtle remains occur. Dr. Wortman indulges here in an interesting speculation; "when the lake disappeared, it can be conjectured that *Patriofelis* took to the open sea, and finally came to feed upon fish exclusively. It is further conceivable that in their new habitat their swimming power was gradually increased, and, owing to the soft nature of their food, the great strength and power of the jaws were gradually lost, and the teeth became gradually modified into the simple degenerate organs which constitute the dental equipment of the modern seals."

In this volume Mr. Chapman presented a long paper on the Birds of the Island of Trinidad; Dr. Allen furnished seven articles on mammalogy; Mr. Beutenmüller a very useful descriptive catalogue of the Orthoptera, found within fifty miles of New York City, and Professor Whitfield an instructive display of the resemblance to, and probable identity with, modern marine algæ, of Trenton age fossils, previously referred by Hall to graptolites.

Volume seven, in its contributions to science, was most distinguished by the papers it contained on Vertebrate Paleontology. These were the Fossil Mammals of the Puerco Beds, of the Uinta Basin, Perrissodactyls of the Lower Miocene White River Beds, and the Osteology of Agriochærus. Dr. Allen provided a careful analysis of Robert Kerr's English translation of 'The Systema Naturæ of Linnæus, as lately published, by the learned Professor Gmelin of the University of Göttingen' issued in 1792, which analysis afforded a useful nomenclatural essay, and belonged to that species of scientific work which may be designated as 'housecleaning.' Kerr's specific and generic names were standardized, and their relevancy or irrelevancy considered. Mr. Beutenmüller gave another of his useful catalogues of insects found within fifty miles of New York City, this being in this instance the *Sphingidæ* or Hawk-Moths. Dr. Hovey contributed notes on New York Island minerals, and Mr. Chapman ornithological notes on Trinidad Birds. Volume eight of the Bulletin (1896) opened with three articles on changes in the plumage of birds, two studies of the Dunlin, Sanderling and Snowflake by Mr. Chapman, and a short general discussion of 'alleged changes of color in the feathers of birds without moulting' by Dr. Allen. These were possibly occasioned by Gätke's notable proposition that the plumage of birds changed without moulting. Dr. Allen and Mr. Chapman's conclusions constituted a refutation of Gätke's heterodox thesis.

The papers on vertebrate Paleontology were continued, and amongst them Professor Osborn's 'Cranial Evolution of Titanotherium' possesses extreme interest. This paper forms a model of conciseness and definite aim. It reveals the accentuation and disappearance of morphological characters, and is a contribution to the demonstration of the plasticity of animal forms. Dr. Wortman, somewhat contrasting in treatment, discusses the species of *Hyracotherium* (fossil horse) and straightens out some of the tangled synonomy of these perissodactyls. A paper of critical interest was Beutenmüller's review of the *Sesiidæ*, or clear winged moths, found in America, north of Mexico, and which was a contribution preliminary to his Memoirs, yet unpublished, on this family.

Archæology appears for the first time in three papers by A. E. Douglass, M. H. Saville, and James Teit, the first being an attempt at a table of geographical distribution of American Indian Relics.

Papers on Mammalogy, Ornithology, Entomology, and invertebrate Paleontology are continued, and the enumeration and notes on Birds in Yucatan, by Mr.

Chapman, seems particularly interesting. The volume closes with a second contribution on the Geology of Lake Champlain, by Professors Brainard and Seely, in which the Chazy beds of that instructive region are especially discussed.

Bulletin nine contains twenty-four articles and was a very exhaustive display of the scientific activity of the corps of research in the Museum. Some papers were of exceptional merit as Dr. Wortman's admirable review of the Ganodonta, a suborder of the Sloths, Dr. Matthew's revision of the Puerco Fauna, and Dr. Boas' Decorative Art of the Indians of the North Pacific Coast.

In the first Dr. Wortman established the strong probability that the sloths of South America were derived from the Ganodonta of North America ; in the second Dr. Matthew revised the Puerco Fauna, and accentuated the 'entire distinctness of the species of the upper and lower beds,' and in the third Dr. Boas painstakingly analyzes the scheme, motive, and meaning of the conventionalized and derivative decorative art of the Indians of the North Pacific coast of America.

The systematic and descriptive papers of J. A. Allen, Frank M. Chapman, William Beutenmüller, were continued. Professor Osborn contributed an authoritative paper on 'The Huerfano Lake Basin, Southern Colorado, and its Wind River and Bridger Fauna.' Professor Whitfield publishes in this volume of the Bulletin a paper of considerable interest, being a description of species of Rudistæ, a remarkable group of Lamellibranchs or bivalves which are only known from the Cretaceous, these here described by Professor Whitfield coming from Jamaica. Professor Whitfield contributed a second paper on the peculiar genus *Barrettia* which Woodward, who instituted the genus, considered, though with hesitation, as a bivalve shell. Professor Whitfield reverts to Woodward's alternate suggestion that they might be corals, and delicately emphasizes the considerations favoring this view.

A paper of zoological importance was devoted to a preliminary description of a new mountain sheep (*Ovis Stonei*), by Dr. Allen. This attractive ruminant was obtained on the headwaters of the Stickeen River, British N. W. Territory, near the Alaskan boundary, at an altitude of 6500 feet. Color, size and character of horns seem to distinguish it as new.

This volume of the Bulletin contains a description of an extraordinary Terra Cotta figure from the Valley of Mexico which presents a life-size figure of a singing man, with arms extended and mouth opened, dressed apparently in armor. This really effective and striking relic was described by Mr. Marshall H. Saville.

Other papers by Juan Vilaro and Tarleton H. Bean conclude the volume.

The tenth volume of the Bulletin contains a very valuable revision of the Red Squirrels or Chickarees by Dr. Allen, which, in a subject of great difficulty, must rank high amongst these reconstructions of this phylum. Dr. Wortman produced for this volume a masterly study of the 'Extinct *Comelidæ* of the U. S.' It perhaps may rank higher than any of this writer's contributions to these bulletins. The conclusions are fragmentary, but the light secured was concentrated upon a difficult and intricate theme. Professor Osborn contributed five papers on vertebrate paleontology of varying interest, but all of scientific importance. To a less technical scrutiny the notes on the great Dinosaur (*Camarasaurus*) seem the most interesting. Mr. Beutenmüller continued his most useful diagnoses of insects (Lepidoptera) with especial reference to those near New York.

Dr. Lumholtz furnished notes on the Huichol Indians of Mexico, and, in conjunction with Dr. Alës Hrdlicka, a paper upon marked human bones from a Prehistoric Tarasco Indian Burial Place in Michoacan, Mexico. The former, according to the writer were almost an unknown Indian tribe of about four thousand, living in a mountainous country, difficult of access, in the northwestern part of the State of Jalisco, on a spur of the great Sierra Madre. Their great interest arises from their religious proclivities, and while nominally Christians, their peculiar symbolism and intricate ritualistic usages, retain a trace of their pagan character, and in them, it is suspected, there remain relics of the ancient Cuachichilian culture. In this bulletin a paper by Dr. Lumholtz and Hrdlicka on marked human bones revealed an odd practice of marking or notching the bones of the dead. These bones are regarded as trophies "from fallen enemies, and the grooves signified the number slain by the owner of the bone."

Dr. Allen, Mr. Chapman, Dr. Bean, supplied papers on mammals, birds, fishes, and Dr. E. A. Mearns a general study of the fauna of the Hudson Highlands.

Volume eleven of the Bulletin is entirely devoted to a Catalogue of the Type specimens contained in the Hall collection of fossils. The Hall collection contains a great number of the original specimens described in the Paleontology of New York, and a complete list of these is of importance. This Catalogue was prepared by Professor R. P. Whitfield assisted by Dr. E. O. Hovey.

Volume twelve contained twenty-one papers quite evenly distributed amongst the subjects hitherto treated in the Bulletin. Some important additions were made to North American mammals by Dr. Allen from the results of the Constable Expedition to Arctic North America conducted by A. J. Stone. Amongst these were further notes on the new Mountain Sheep (*Ovis Stonei*), a new Jumping Mouse, four new Voles. Dr. Allen also described in this Bulletin new rodents from the United States and South America; Mr. Chapman reviewed the birds taken on the Peary Expedition to Greenland; Mr. E. W. Nelson gave descriptions of new squirrels from South America; Mr. Gerritt S. Miller of new bats from the West Indies.

A very interesting paper by Dr. Alës Hrdlicka on an 'Ancient Anomalous Skeleton from the Valley of Mexico' revealed human remains having 26 ribs instead of the usual number 24. Furthermore this additional pair of ribs appears to be cervical, as there was found 'an articular facet on each side of the seventh cervical,' which, if granted, proved an extension of the thorax upward. There was also a partial blending of the first and second ribs, or there was a 'bicipital rib.' The interest of these facts appears to lie in the indicated reversion to lower animal forms. The tibiæ are flattened (platycnemic), with a backward inclination of their heads. Whether these remains were Aztecan or Taltecan, the author of this paper was unable, from known data to say.

Mr. Beutenmüller continued his able synopses and revisions of Lepidoptera.

The papers which conferred the most distinction on this volume were those relating to vetebrate paleontology. These were four in number from the pens of Professor Osborn, Dr. Wortman and Dr. Matthew. The ancestry of the dogs, foxes, otters, was discussed, by which it was shown that their descent could be traced from the Eocene, that the family of the Procyonidæ (a small family holding the American raccoons) could be traced as an offshoot of the dogs in the later Eocene (Oligocene), that the South American Foxes came from North American Miocene species, and that the establishment of the new family Viverravidæ was necessary. This family was considered as "the forerunner of the Viverrine phylum whose members towards the close of the Eocene migrated to Asia."

The second paper by Dr. Wortman on *Oxyæna lupina* Cope, contained a full description of this species, typical of one family of the *Creodonta* (flesh-eaters). Dr. Matthews's paper was a careful tabulation of the fauna of the fresh water tertiary of the west. Professor Osborn contributed his third paper on Dinosaurs making a comparison of the fore and hind limbs of these extraordinary creatures, the dimensions of whose legs, in some cases, (*Brontosaurus*) reached the extreme limit of ten feet.

This twelfth volume of the Bulletin closed with a description of the Eskimo of Smith Sound by A. L. Kroeber. These were Ross' Arctic Highlanders, and the subject of Mr. Kroeber's paper was the six natives secured by Lieut. Peary and brought to this city in 1897. The implements of these singular aborigines were described, and their sociology, religion and cosmology.

These Smith Sound Eskimo are regarded as, ethnologically, similar to the Greenland Eskimo, and claims for their distinctness and insulation are repudiated.

Their religion is vague, but practically centers around the 'medicine man,' or shaman, their morals dubious, and their government formless.

Amongst shorter papers in the tenth volume was a notice of a superb specimen of *Madrepora palmata* which Professor Whitfield obtained in the Bahamas and which now forms a conspicuous ornament of the Coral collection in the Museum halls.

These Bulletins of the Museum have now an established reputation, and form a feature as important in its scientific life, as does the beautiful or appropriate exhibition of its collections in its educational work.

L. P. Gratacap.

THE VERTEBRAL FORMULA IN DIPLODOCUS, MARSH.

In the Memoirs of the American Museum of Natural History, Volume I., Part V., Professor Henry F. Osborn has given a careful and exceedingly interesting account of the skeleton of a *Diplodocus* discovered in 1897 near the Como Bluffs in Wyoming by an exploring party sent out by the American Museum.

In the summer of 1899 the expedition sent out to the fossil fields of Wyoming by the Carnegie Museum at the instance and expense of the generous founder of the institution, succeeded in discovering a second skeleton of *Diplodocus*, which furnishes information as to many portions which were lacking in the specimen belonging to the American Museum. The two specimens are in many respects complementary to each other. The specimen described by Professor Osborn consisted of the left neural arches of three cervicals; eight posterior dorsals lacking the centra; the sacrum lacking the first and second centra and consisting of four vertebræ; caudal vertebræ Nos. 1–21, and 23–27, complete with chevrons; portions of caudals 32, 33, and 35 (estimated); the ribs of the three posterior dorsals; the left ilium and ischium; the upper three-fourths of the left femur, and the right scapula. The specimen belonging to the Carnegie Museum consists of eleven cervicals, ten dorsals, four sacrals lacking the left sides of the centra, the twelve anterior caudals, with chevrons; eighteen ribs, two of them imperfect; the right ilium, and the peduncle of the left ilium; the two ischia and the two pubic bones; the right femur entire; the left scapula and coracoid coössified, and the two sternal plates. The work of excavation has not yet been completed, having been interrupted in the latter part of September, 1899, by the advent of severe weather. It has been resumed at this date and it is hoped that further uncovering of the hillside, on which the discovery was made, will result in the discovery of some additional portions of the skeleton.

It is not the intention of the writer in these lines to enter into a description or discussion of these exceedingly interesting and important remains, save for the purpose of calling attention to the fact that the specimen under consideration appears to throw light upon the hitherto unsettled number of the dorsal vertebræ in the Sauropoda. Professor Marsh has figured the number of dorsals in *Brontosaurus* as fourteen. Professor Osborn in his memoir says "We may provisionally adopt 15 as the number in *Diplodocus*." The specimen obtained by the Carnegie Museum shows but ten dorsal vertebræ. These vertebræ were found in regular order from the sacrum forward. The six posterior presacral vertebræ interlocked by their zygapophyses. The seventh and eighth presacrals articulated with each other, but were displaced vertically, having been depressed in the mud, which subsequently solidified to form the matrix. The ninth and tenth were also interlocked, and no gap existed between the eighth and ninth except that produced by the depression already noted. The first cervical lying in front of the tenth presacral was displaced at an angle from the axial line of the skeleton, but if restored to a normal position the gap between it and the most anterior of the dorsals would have been filled, and, now that these vertebræ have been freed from the matrix, they are found to closely articulate. The cervicals were for the most part interarticulated, all lying in such position as to show the serial order.*

*I am indebted to Mr. A. S. Coggeshall, the Chief Preparator in the Department of Vertebrate Paleontology in the Carnegie Museum, for the statements given above as to the exact location *in situ* of the vertebræ. Mr. Coggeshall preserved accurate memoranda of locations in the field-notes, which he made while assisting in the exhumation of the remains.

From the foregoing facts it appears that the number of dorsal vertebræ in *Diplodocus* is only ten.

A further confirmation of this view is derived from the number of ribs which were discovered. Beginning with the dorsal vertebræ immediately before the sacrum we find the short posterior ribs as delineated by Professor Osborn, followed, as we advance, by ribs rapidly increasing in length, until we find attached to the seventh presacral a rib five feet eight and a half inches in length. This represents the maximum development in the length of the ribs. Both ribs of the seventh presacral have been recovered. We have not found time as yet to carefully adjust the ribs to the vertebræ, but we have every reason to think that we have recovered all of them except two. Twenty is then the number of the dorsal ribs in *Diplodocus* and the inference is plain that there must have been but ten dorsal vertebræ.

The correspondence between the structures of the sacral region in *Diplodocus* and those found in the struthionid birds has already been pointed out by Professor Osborn. I may say that this likeness is further shown in the number of the dorsal vertebræ, and the conformation of the scapular girdle, as well as in certain features of the cervical vertebræ. These colossal reptilia reveal in portions of their osseous framework marked tendencies in the direction of a development along avian lines.

Cervicals	at least 13	Eleven are found in the specimen at the Carnegie Museum, atlas and axis being as yet undiscovered. There may have been more than thirteen cervicals, though their great length, averaging two feet, seems to militate against the existence of many more than the number given.
Dorsals	10	
Sacrals	4	Both specimens agree in showing only four sacrals.
Caudals	32–35 (Osborn).	

Collating the facts ascertained from the two skeletons of *Diplodocus*, the one in the American Museum, and the other in the Carnegie Museum, we ascertain that the vertebral formula of *Diplodocus* was as given on page 817.

A paper giving a full account of the specimen belonging to the Carnegie Museum will appear in the Memoirs of this Institution.

W. J. HOLLAND.

CARNEGIE MUSEUM,
May 10, 1900.

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*UNVEILING OF THE HUXLEY MEMORIAL.**

A LARGE assembly, representative of many interests and many nationalities, the Prince of Wales at their head, met in the great hall of the Natural History Museum, South Kensington, on Saturday, to do honor to one who, in a degree rarely paralleled, was at once a great man of science and a great man of literature. The occasion was the acceptance by the Prince of Wales, on behalf of the trustees of the British Museum, of a statute of Mr. Huxley, presented in the name of the subscribers by the veteran Sir Joseph Hooker, and may be regarded in some sense as an *eirenicon*, for among the official persons present was the Bishop of Winchester, the successor of a doughty opponent of the late Professor ; and the statue faces the stately and simple figure of a former scientific antagonist—Owen. The Prince of Wales was president, Lord Avebury, honorary treasurer, and Professor G. B. Howes, honorary secretary of the memorial committee. Huxley had a rare power of winning the regard and affection of his pupils, and many of them, unknown to fame, came to do him reverence.

Professor Ray Lankester, Director of the Museum, made the following statement: The duty of briefly explaining the nature of the present proceedings has devolved upon me. I feel it to be a great privilege to discharge this duty on the occasion designed to do honor to my venerated master, Professor Huxley. This celebration would have been no less dear to Huxley's fellow-worker and friend, the late Director of this Museum, Sir William Flower, who, unhappily, is no longer with us to witness the completion of the memorial statue which he especially desired to see placed in this hall. A few months after Professor Huxley's death in 1895 a committee was formed for the purpose of establishing a memorial of the great naturalist and teacher. At a meeting of that committee, held on November 27, 1895, at which 250 members were present and at which his Grace the Duke of Devonshire presided, the following resolution was carried : "That the memorial do take the form of a statue, to be placed in the Museum of Natural History, and a medal in connection with the Royal College of Science, and that the surplus be devoted to the furtherance of biological science in some manner to be hereafter determined by the committee, dependent upon the amount collected." From all parts of the world, besides our own country, from every State of Europe, from India and the remotest colonies, and from the United States of America subscriptions have been received for the Huxley Memorial, amounting in all to £3380. (Cheers.) Three years ago the committee commissioned and obtained the execution of a medal bearing the portrait of Huxley, and has established its presentation as a distinguished reward in the Royal College of Science. The republication of the complete series of Huxley's scientific memoirs, which was proposed as one of the memorials to be carried out by the committee, has been undertaken by Messrs. Macmillan without assistance from the committee. I am glad to be able to state that two large volumes of these richly-illustrated contributions to science have

* From the London *Times*.

been already published. Whilst these other memorials were in progress under the auspices of the executive committee they secured the services of Mr. Onslow Ford, R.A., to execute the statue which it had been decided by the general committee to regard as the chief object of the subscriptions entrusted to them. On the completion of the statue the Trustees of the British Museum agreed to receive it and to place it in the great hall where we are now assembled. On behalf the vast body of subscribers to the memorial Sir Joseph Hooker, Huxley's oldest and closest friend, himself the survivor of that distinguished group of naturalists, including Charles Lyell, Richard Owen and Charles Darwin, who shed so much lustre on English science in the Victorian age, will hand over the statue of Huxley to the Trustees of the British Museum. Your Royal Highness has been graciously pleased, as one of the Trustees, to represent them on the present occasion, and to receive the statue on their behalf. The memorial statue of Huxley is the expression of the admiration, not only of the English people, but of the whole civilized world, for one who as discoverer, teacher, writer and man must be reckoned among the greatest figures in the records of our age.

Sir Joseph Hooker said: I have the honor of being deputed, by the subscribers to the statue of my friend the late Professor Huxley, to transfer it to your Royal Highness, on behalf of the trustees of the British Museum, with the intent that it should be retained in this noble hall as a companion to the statues of Professor Huxley's distinguished predecessors, Sir Joseph Banks, Mr. Darwin and Sir Richard Owen. It would be a work of supererogation on my part, even were I competent to do so, to dwell upon Professor Huxley's claims to so great an honor, whether as a profound scientific investigator of the first rank, or as a teacher, or as a public servant; but I may be allowed to indicate a parallelism between his career and that of two of the eminent naturalists to whom I have alluded, which appears to me to afford an argument in favor of retaining his statue in proximity to theirs. Sir Joseph Banks, Mr. Darwin, and Professor Huxley all entered upon their effective scientific careers by embarking on voyages of circumnavigation for the purpose of discovery and research under the flag of the Royal Navy. Sir Joseph Banks and Professor Huxley were both presidents of the Royal Society, were trustees of the British Museum; and, what is more notable by far, so highly were their scientific services estimated by the Crown and their country, that they both attained to the rare honor of being called to seats in the Privy Councils of their respective Sovereigns. With these few words I would ask your Royal Highness graciously to accede to the prayer of the subscribers to this statue, and receive it on behalf of the trustees of the British Museum.

Professor Sir Michael Foster, following, said: Before your Royal Highness unveils this statue it is my duty and privilege to add a few words to those which have just been spoken by the beloved Nestor of biological science. Sir Joseph D. Hooker, born before Huxley was born, a sworn comrade of his in the battle of science, standing by him and helping him like a brother all through his strenuous life, may, perhaps, be allowed to shrink from saying what he thinks of the great work which Huxley did. We of the younger generations, Huxley's children in science, who know full well that anything we may have been able to do springs from what he did for us, cannot on this great occasion be wholly silent. Some of us have at times thought that Huxley gave up for mankind much which was meant for the narrower sphere of science; but if science may seem to have been thereby the loser, mankind was certainly the gainer; and, indeed, it was a gain to science itself to be taught that her interests were not hers alone, and that not by one tie or by two, but by many, was her welfare bound up with the common good of all. To many, perhaps, the great man whose memory we are here met to honor was known chiefly as the brilliant expositor of the far-reaching views of that other great man who through his statue is now looking down upon us. Your Royal Highness is doubtless at this moment thinking of that interesting occasion, fifteen years ago, when you unveiled that statue of Darwin, and you are calling to mind the weighty words then spoken by him whose own statue brings us here to-day. Huxley, it is true, fought for Darwin, and, indeed, 'he was ever a fighter.' But he fought not that Darwin might prevail; he fought for this alone—that the views which Darwin had brought forward might be examined solely by the clear light of truth, untroubled by the passion of party or by the prejudice of preconceived opinion. As he never claimed for those views the infallibility of a new gospel, so he always demanded that they should not be peremptorily set aside as already proved to be wrong. Huxley worked for his fellow-men in many ways other than the way of quiet scientific research. Had we not known this we should have thought that his whole life had been given up to original scientific investigation, so much has the progress of biological science, since he put his hand to it, been due to his labors. On the sands of many a track of biologic inquiry he has left his footprints, and his footprint has ever been to those coming after him a token to press on with courage and with hope. The truths with which he enriched science are made known in his written works; but that is a part only of what he did for science. No younger man, coming to him for help and guidance, ever went empty away; and we all—anatomists, zoologists, geologists, physiologists, botanists, and anthropologists—came to him. The biologists of to-day, all of us, not of this country alone, but of the whole world of science, forming, as it were, a scattered fleeting monument of this great man, are proud at the unveiling of this visible lasting statue here. May I crave your Royal Highness's permission to seize this opportunity to assure you incidentally, but none the less from the bottom of our hearts, on the part of men of science, that we in common with all her Majesty's subjects are rejoicing that you escaped the dreadful peril to which a few days back you were exposed, and to express to you our continued esteem and respect.

The Duke of Devonshire said: I had the honor nearly five years ago of presiding over a meeting of the committee which had been formed for the purpose of establishing a memorial to Professor Huxley. I have now to report to your Royal Highness that the labors of that committee are completed, and that they desire to present the statue to your Royal Highness on behalf of the Trustees of the British Museum. The subscriptions to this memorial, as Professor Ray Lankester has already observed, have come not only from this country, but from every other civilized country in the world. This beautiful statue, the work of Mr. Onslow Ford, has been completed under the superintendence of the committee, but the real memorial of the man is to be found in his writings and in the influence which he exercised and is still exercising upon the minds of younger men, many of whom, we may hope, will in the future emulate his noble example.

The Prince of Wales then, amid cheers, withdrew the covering from the statue, and said: I consider it a very high compliment that I have been asked to-day by the Huxley Memorial Committee to unveil this statue, and to do so in the name of the Trustees of the British Museum, of whom I have the honor to be one. I have not forgotten that 15 years ago I performed a similar duty in connection with the fine statue of the celebrated Charles Darwin, which is at the top of the stairs, that was similarly handed over to the British Museum. We have heard to-day most eloquent and interesting speeches with reference to the illustrious man of science and the great thinker, Professor Huxley. It would therefore be both superfluous and I may even say unbecoming of me to sound his praises in the presence of so many men of science, who know far more about all his work than I do. I can only on my own part endorse everything that has fallen from the lips of those gentlemen who have spoken, and I beg only to repeat what great pleasure it has given me for the second time to have performed the interesting ceremony of taking over the statue of another great and illustrious man of science.

The statue is of marble and represents Huxley seated with his head somewhat bent, his right hand grasping the end of the chair, and his left clenched, as though, perhaps, to enforce an argument. He wears a gown and hood to indicate the honors of which, in more than one university, he was the recipient. The bushy eyebrows and the characteristic combativeness of his strong face are well realized, though in matter of likeness some who knew him well were not altogether satisfied. The work is of great beauty and finish, especially in the decoration of the chair. But it is permissible to doubt the suitability to a great personality not trained in a university or the inheritor of traditional methods, of the sitting posture and the academic attire. A great champion of the causes he espoused and formidable opponent of what he regarded as outworn theories, a standing attitude and such simple drapery as Owen wears before him might have better represented the man as he was in the flesh. But the work unquestionably possesses great artistic merit. The statue bears the inscription—

THOMAS HENRY HUXLEY,
Born May 4, 1825.
Died June 29, 1895.

SCIENTIFIC BOOKS.

A Manual of Zoology. By T. JEFFREY PARKER and WILLIAM A. HASWELL. Revised and adapted for the use of American schools and colleges. New York, The Macmillan Co. 1900. Pp. xxv+563; 327 figs. Price, $1.60.

This useful manual has been abridged from the well-known larger *Text-book of Zoology* by the same authors, with the intention of meeting the needs of students in the higher classes of schools. The book retains many of the merits that won so favorable a reception for the larger work. It is concise, clearly written, well illustrated and abreast of the times. It may nevertheless be questioned whether the 'Manual' is as well adapted to its purpose as the 'Text-book.' However widely teachers of zoology in the schools differ in regard to the plan and scope of work, most of them will probably agree that a text-book satisfactory for their purpose is hardly to be made by simple abridgement of a larger technical work, as has been done in this instance. By following this method the authors have produced a work which, despite many admirable features, is too largely a mass of technical anatomical detail, some of which might well have been sacrificed to make room for fuller accounts of the general natural history and relationships of animals, of physiological principles and of broader biological questions.

We fear that the American teacher who reads in the preface that this edition has been 'adapted for the use of American schools' will hardly feel himself fairly treated when he searches in the text for the basis of this statement. Here and there reference is incidentally made to characteristic American forms, and a few—a very few—such forms are figured. With few exceptions, however, both the types and the forms described for comparison are European species, some of which differ materially from their American cousins; and we think the American editor might have taken the trouble to select American representatives of such common types as the tortoise, frog, salamander, snail, grass-hopper, *Nereis* and sea-anemone, or to describe the anatomy of the common squid instead of the European cuttle-fish. The book is nevertheless a very excellent one and will doubtless be welcomed by American teachers.

E. B. W.

A First Book of Organic Evolution. By D. KERFOOT SHUTE, A.B., M.D. Chicago, The Open Court Publishing Company. 1899. Pp. xvi + 285.

This is a brief account of some of the facts and theories that cluster around the central idea of Organic Evolution. The principle of heredity forms the guiding idea in connection with which is given, among other things, a discussion of the cell-theory, of variation, of the influence of environment, natural selection and the evolution of man. The last section gives a synopsis of the classification of animals, and, *in a half page*, of plants. There is a list of works of reference that may be useful to the general reader, and a glossary of terms that is on the whole accurate. The majority of the illustrations are good, especially the series of full-page plates prepared especially for the work. In the chapter on man sociological and ethical questions are discussed, the idea of design is upheld, and the author decides for a cosmic soul that 'may be self-conscious, wills, thinks, acts and designs.' "Man is the highest and greatest fruitage of the tree of animal life." "He has been the goal and is the completion of organic evolution." "He is not only the highest creature that has ever appeared on the globe, but it seems a safe induction to say that he is also the highest animal that evolution will ever develop here."

If anyone doubts that man is 'the topmost flower on the highest and *straightest* branch of the tree of life,' he has only to consult the diagram on p. 182.

In reading 'this little book' one has continually to remind oneself that it is a 'first book,' that is a primer, and that all the author has tried to do is to sketch an *outline* of modern biology as related to the theory of descent. Considering the limits of space and the almost infinite number and variety of the data from which selection is to be made, it must be admitted that the author undertook a difficult task. When we say, that one altogether unfamiliar with scientific biology might digest the whole book without acquiring any very serious errors of opinion, we are giving high praise. But, if such an one were to come later to the practical study of medicine or advanced biology, he might be surprised to learn, that the diagram of the maturation and fertilization of the *human* ovum given on p. 30 is a pure figment of the imagination, seeing that no one has ever observed these phenomena in the egg of man, that the chromatin of the nucleus is ever in any other form than that of threads, and that therefore *chromatin* and *chromosomes* are *not* synonymous terms (glossary and *passim*), that the nutrition of a cell does *not* include irritability and contractility (p. 7), that a cell is not necessarily *encysted* because it possesses a cell-wall, that parthenogenesis is not a form of budding (p. 42), nor is the fertilized egg '*hermaphrodite*' (p. 43). These are but a few examples of the altogether uncritical use of illustrations and terms, which is only partly excusable on the ground of the popular nature of the book.

The book is also dogmatic. A certain amount of dogmatism is unavoidable, and perhaps even to be desired in so popular a work. But it would be difficult to justify the following statement: "Intemperate people * * * also transmit" (by inheritance to their offspring) "the fatal tendency to crave for *the very substances* that have acted as poisons on these germ-cells before and after fertilization." The transition from fact to theory is, indeed, everywhere so easily made, that one uninitiated must be in constant doubt of his footing.

While the book never rises above the intellectual or literary level of the freshman class in college, it seems to me perhaps as good an epitome as we possess, within so narrow limits, of the facts and principles of organic evolution.

Frank R. Lillie.

Produits aromatiques artificiels et naturels. By Georges F. Jaubert, Docteur és Sciences, ancien Préparateur de Chimie á l'École Polytechnique. (Encyclopédie scientifique des Aide-Mémoire.) Petit in-8. Pages 169.

This is the sequel to the author's previous book 'Matières odorantes artificielles' (reviewed in this Journal, XI., 710), and resembles it closely in all respects. The former volume contained the nitro and halogen derivatives, phenols, and aldehydes; while, in the present one, the remaining odoriferous substances are grouped in the following chapters:

I. Aromatic alcohols (34 listed).
II. Aromatic acids and their derivatives (70 listed).
III. Terpenes (22 listed).
IV. Camphors (20 listed).
V. Terpene alcohols, aldehydes, and acids (10 listed). This includes such compounds as geraniol, citral and ionone, but no terpene *acids* are mentioned.

There are in all 169 pages—41 pages of text (including the Preface), 121 pages of tables, and 7 pages of index.

No one could guess from the title just what might be the scope of this book, and most chemists, even after a careful examination, will still be in doubt as to what the author is endeavoring to tabulate, for many of the compounds listed are 'aromatic' only to the extent of containing a benzene nucleus and have not the remotest interest in perfumery, although the author's idea of a perfume seems to be different from that of most chemists, since he says on page 48: "Les acides benzoique et cinnamique sont á l'état pur des parfums puissants."

The column in the tables headed 'Literature and Patents' is unsatisfactory, being either meagre and not up to date, or else merely a reference to some larger work and not to the original article at all; while, in spite of the heading, not a single patent reference is given in the entire book.

By endeavoring to expand to two volumes what could much better have been given in one, the author has been forced to introduce a large amount of wholly extraneous material, and has thus completely defeated the main object of memory aid, which is to present the important facts concisely and entirely free from all that is either irrelevant or of only remote interest.

Marston Taylor Bogert.
Columbia University.

The Compendious Manual of Qualitative Chemical Analysis of C. W. Eliot and F. H. Storer, as revised by W. R. Nichols. Nineteenth edition, newly revised by W. B. Lindsay, Professor of general and analytical chemistry in Dickinson College, and F. H. Storer, Professor of agricultural chemistry in Harvard University. New York, D. van Nostrand Co. 1899. Pp. 202. Price, $1.25.

It is now over thirty years since the first edition of this book was published, and throughout this time it has held its place as one of the best simple manuals. The present edition is thoroughly modern and satisfactory. It is the avowed scheme of the editors to give but one method for each separation, and considering the elementary nature of the book their choice of methods must be commended. In its present form 'Eliot and Storer' will maintain its past reputation.

E. Renouf.

Victor von Richter's Organic Chemistry or Chemistry of the Carbon Compounds. Edited by Professor R. Anschütz, University of Bonn. Authorized translation by Edgar F. Smith, Professor of Chemistry, University of Pennsylvania. Third American from the eighth German edition. Vol. II. Carbocyclic and Heterocyclic Series. Philadelphia, P. Blakiston's Sons & Co. 1900. Pp. 671. Price, $3.00.

The first volume of this book was reviewed in Science, Vol. IX., p. 729. The praise given to the first volume should be extended to the second. One needs merely to open the volume at random and read, to recognize the merits of the book. The chapters on diazo compounds, on azines, on terpenes, on quinones are notable examples of thoroughness, and of the amount of recent research often condensed into a few lines.

It must be noted that this is not a book for beginners. A student with some knowledge of organic chemistry could use it as a text-book if it were possible for him to resolutely confine his attention to the 'coarse print.' But it is as a reference book for the student who wishes to refresh his memory not merely of one compound, but of the complete chemistry of a group of compounds, that the work is of peculiar value, and may be cordially recommended.

Edward Renouf.

Optical Activity and Chemical Composition. By Dr. H. Landolt, Professor of Chemistry in the University of Berlin. Translated, with the author's permission, by John McCrae, Ph.D. Whittaker and Co., London, and the Macmillan Co., 66 Fifth Ave., New York. 1899. Small 8vo. Pp. 158. Price, $1.00.

This little book forms a translation of the eighth chapter of the first volume of Graham-Otto's 'Lehrbuch der Chemie' and is a smaller and condensed edition of the author's well-known 'Das optische Drehungsvermögen organischer Substanzen und dessen praktische Anwendungen,' published in 1898. The subject is treated under three heads: I. General Principles of Optical Activity; II. Connection between the Rotatory Power and the Chemical Composition of Carbon Compounds, and III. Connection between Degree of Rotation and Chemical Constitution. Under the first head are discussed such subjects as crystal rotation, liquid rotation, molecular rotation, measurement of rotation, specific rotation, variations of specific rotation with concentration and change of rotatory power of dissolved substances with time, multirotation. Under the second head are treated optical modifications, the investigations of Pasteur, the van't Hoff and Le Bel theory, calculation of the number of optically active isomers of a compound from the number of asymmetric carbon atoms which it contains, the formation and properties of racemic compounds, resolution of racemic substances into the antipodes, formation and properties of the active modifications, transformation of one antipode into the other, the configurationally inactive non-decomposable modifications and their differences from racemic inactive isomers. Under the third head are taken up isomeric compounds, including stereoisomers, homologous series, influence of the mode of linkage of the carbon atoms, summation of the rotatory actions of several asymmetric groups, optical superposition and the dependence of the rotatory power of an active atomic grouping on the masses of the four radicles united to the asymmetric carbon atom, the hypothesis of Guye.

The translation is well done and the subject is brought up to date by notes and additions by the translator. The subject is presented in a very attractive and readable form and the book can be heartily recommended to anyone, who desires to know the present state of our knowledge regarding the relation existing between optical activity and chemical composition; though for more detailed information Landolt's 'Das optische Drehungsvermögen organischer Substanzen und dessen praktische Anwendungen' must be used.

W. R. Orndorff.

SCIENTIFIC JOURNALS AND ARTICLES.

The *Osprey* for April, a little belated, opens with the fourth part of 'Birds of the Road,' by Paul Bartsch. Wm. L. Wells describes the 'Nesting of some Rare Birds,' including the yellow rail and solitary sandpiper, and Theodore Gill presents the second part of 'William Swainson and his Times' which carries Swainson through his journey to Brazil. In editorial comments under 'Birds and Women' the situation is summed up in a few words "If the demand exists for anything, that demand will be supplied if it can be done with a profit." Under Notes is to be found an extraordinary account of 'How Two Lions stopped an African Railroad,' and other matters of interest.

A Bulletin of Mathematics and of the Physical and Natural Sciences, to be published semi-monthly in the interest of teachers in Italian schools, has been established by Professor Alberto Conti, of Bologne.

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

The 101st meeting of the Society was held at the Cosmos Club April 11, 1900.

The following papers were presented on the regular program:

Physiographic Development of the Black Hills: By MR. N. H. DARTON.

The principal period of uplift of the Black Hills dome was in the earlier tertiary time. During the progress of this uplift the larger features of the present topography were developed. The main north and south divide lies west of the apparent center of the uplift as the dome now stands, the cause for which is not yet ascertained.

The area of deposition of the White River deposits of the late Oligocene extended far up the flanks and into the valleys of the Black Hills apparently completely filling many of the old depressions. Following White River deposition the Black Hills were lifted both as a whole and also with increased doming and the new drainage was in part revived and in part superimposed. In the superimposition of drainage on the east side of the Hills there is evidence of a general tilting to the northeast so that portions of the revived pre-Oligocene valleys now appear to be robbed by their neighbors to the north, the present channels offsetting at intervals in that direction across former divides. A period of early Pleistocene base-leveling is recognized which had much to do with readjusting the drainage on the east side of the Hills. It cut deeply into the White River deposits planing them off over wide areas and depositing a mantle of gravels on plains now adjoining the Hills at high levels, extending up the valley as benches and passing over many saddle-shaped divides. Leveling and mapping of their features are now in progress by Mr. Darton with a view to determining quantitatively the amounts of uplift at the several periods and their variations from place to place through the Hills.

River Terraces in Southwestern Colorado: By MR. A. C. SPENCER.

The rivers draining the San Juan mountains emerge from deep canyons in palæozoic and older rocks upon a comparatively low-lying region of younger rocks, comprising sandstones and shales. These softer rocks have been easily reduced by erosion and in the vicinity of the rivers terraces have been produced at altitudes up to 500 feet above the present channels.

The highest terraces may be correlated from the Animas River at Durango, westward to the Mancos River and McElmo Creek, and may be recognized in the lower valley of the San Miguel River. Similar terraces upon the Uncompahgre River near Montrose, and along the Gunnison and Grand rivers are also believed to correspond. These facts are taken to indicate the amount of recent erosion which the rivers have accomplished, and as evidence of regional uplift. There were several distinct upward movements, all prior to the glaciation of the San Juan mountains.

Some Coast Migrations in Southern California: By MR. BAILEY WILLIS.

THE 102d meeting was held at the Cosmos Club, May 2, 1900.

The following papers were presented on the regular program:

A Reconnaissance from Pyramid Harbor to Fortymile River, Alaska: By MR. ALFRED H. BROOKS.

The route followed extends westward from Lynn Canal along the northern front of the St. Elias Range to the head of the White, Tanana and Nabesna rivers. At the Nabesna river it turned northward and, crossing the Tanana, extended on to Eagle City on the Yukon. The chief orographic features are the Coast Range of Lynn Canal which extends westward beyond Lake De Zar Diash, the St. Elias Range which forms the Coast Range westward from Cross Sound, the Nutzotin Mountains, which are a minor range running parallel to the St. Elias near the headwaters of the Tanana and White rivers, the Mentasta Mountains, which are a westward extension of the same range and connect them with the Alaskan Range. From the base of these mountains the Yukon Plateau extends northward, and is a dissected upland sloping gently to the west. The drainage of the region is taken by the Chilkat river to Lynn Canal, by the Alsek southward to the Pacific, and by the Tanana and White rivers which are tributaries of the Yukon. The oldest rocks of the region are the gneisses and crystalline schists forming a broad belt between the

Tanana and the Yukon. The next succeeding formations which overlie the gneisses unconformably are grouped together as the Older Sedimentary Series, and include the gold bearing horizons of the Fortymile region. It is probably of Silurian and pre-Silurian age. A second series of Paleozoic rocks are classed as the Younger Sedimentary Series. These are largely Devonian and Carboniferous as determined by fossil evidence. They include a broad belt which was traced westward from Lynn Canal to the Nabesna river. This younger series is cut by large masses of intrusive rocks. The largest belt of these intrusives is the Coast Range granite which extends westward to the White river.

Along the northern base of the St. Elias Range were found considerable areas of effusive rocks which have often been tilted, forming monoclinal uplifts dipping southward and faulted on the north side. These effusives, together with those of the Mount Wrangell group, are probably both Tertiary and recent. The Pleistocene is represented by sands, silts and gravels. The northern limit of glaciation is traced westward as far as the Nabesna river. During the maximum extension of the Cordilleran ice sheet the White River, Tanana, and Nabesna valleys were occupied by glaciers which extended far north of the general limit of glaciation. The white volcanic ash of the upper White river was traced westward as far as the Fortymile basin. It is plainly an æolian deposit.

The copper deposits are largely placer, and are of native copper. Small veins of native copper were found in dioritic rocks connecting white Carboniferous limestone, and also in the white limestone itself near the contact. The gangue mineral is calcite.

Reconnoissance along the Chandlar and Koyukuk Rivers, Alaska: By Mr. F. C. Schrader.

Geology of the Silver Peak District, Nevada: By Mr. W. W. Turner.

The Silver Peak District lies in western Nevada near the California line. The scenery is typical of the Great Basin; isolated ranges lying between broad valleys, most of which are sinks. In the lowest part of most of the valleys are playas, while between the ridges and the playas are detrital slopes of Pleistocene age, often of vast extent. The configuration of the country is in the main due to differential uplift and subsidence, and the valleys are thus chiefly of orographic origin. Such a series of displacements must have been accompanied by normal faulting, and scarps, originating in this way, are to be seen in the region. In general the main faults trend north and south and east and west.

Subsequent erosion has greatly modified the shapes of the ridges, and partly filled the valleys with detritus.

In Miocene time much of the Silver Peak Range, which attains an elevation of 9500 feet, did not exist. Over a portion of its present site was a broad basin occupied by Lake Esmeralda. The deposits of this lake underlie the valleys and form foothill areas and arch up over the central part of the Silver Peak Range, showing that these mountains are in part late Miocene or post-Miocene origin.

With the exception of certain gneisses of doubtful age the oldest rocks of this district are Lower Cambrian, the Middle Cambrian and Silurian being also represented. All of these paleozoic rocks are rich in fossils. The late Eocene or early Miocene beds of Lake Esmeralda contain an abundance of fossil fish, dicotyledonous and other leaves, silicified wood, and fresh-water mollusks. According to Professor Knowlton the dicotyledonous leaves are repesented by holly, oak, sumach, and bayberry, showing that the climate has undergone a great change since Miocene time. From a well watered region it has become an arid one in which there are no running streams.

Volcanic activity began in this region in early Paleozoic time but after these first rhyolitic flows the volcanic forces appear to have been inactive for a very long period. During and subsequent to the deposition of the lake beds rhyolitic and andesitic eruptions occurred in great volume, followed near the beginning of the Pleistocene by eruptions of pumice and basalt, one crater being clearly of Pleistocene age.

F. L. Ransome,
David White,
Secretaries.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE evening of May 5th, that of the 324th regular meeting, was devoted to a joint meeting of the Chemical Society and Biological Society, the subject for discussion being the 'Chemical and Biological Properties of Protoplasm.' The discussion was introduced by O. Loew, H. N. Stokes, H. J. Webber and A. F. Woods, the first two speakers paying special attention to the chemical side of the question, the others taking the ground that chemical changes alone could not account for the vital phenomena exhibited.

H. J. WEBBER,
Secretary of Joint Meeting.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

THE regular meeting of the Section was held on April 23d. Dr. Livingston Farrand spoke on 'Recent Researches in Central Australia,' calling attention to certain points of particular significance in Messrs. Spencer and Gillen's book, 'The Native Tribes of Central Australia,' which appeared last year. Special emphasis was laid on the suggested origin of the religious side of totemism as indicated in the 'Intichinma' ceremonies of the Arunta tribe, which are directed apparently solely toward the end of increasing the supply of the totem animals and plants of the district, each totem group being charged with the treatment of its own totem object and its multiplication for the benefit of the other members of the tribe. The well-known prohibition against killing and eating the totem seems to hold in this region, but tradition and ceremony point to a time when this was not the case. This economic explanation of the custom is the first satisfactory one yet offered and is plausible for the tribes under discussion even though it may not hold for other parts of the world. The social aspect of totemism with its marriage regulations still remains a problem.

The second paper was presented by Dr. Franz Boas on the subject 'The Eskimos of Cumberland Sound.'

The material on which this paper was based was collected by Captain James Mutch. A full version was given of the myth of the creation of land and sea animals, and a description of the beliefs of the people in regard to souls and in regard to a series of heavens and underground worlds which are the abodes of the deceased. A number of taboos were described, and their explanation as given by the Eskimos was stated. They believe that the transgression of a taboo prescribed after the death of an animal causes the transgression to become fastened to the soul of the animal, which goes down to the mistress of the lower world, where the transgression makes the hands of the deity sore. This enrages her, and she causes famine and misfortunes of all kinds.

CHARLES H. JUDD,
Secretary.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

AT the meeting of the Academy of Science of St. Louis on the evening of May 7, 1900, the following subjects were presented:

Mr. Charles Espenschied gave an interesting address on modern flour milling, tracing the history of the preparation of grain for human food, the developments since 1865, when it was discovered that 'middlings,' when properly cleaned, could be reground into the best of flour, and the introduction of chilled steel rolls to replace the older millstones, so that to-day a good mill separates practically all of the flour in a grain of wheat in its most perfect form and is almost automatic in operation. It was stated that while larger mills are in operation, the most economical mill in use at the present time is that having a daily capacity of about one thousand barrels of flour.

Dr. H. von Schrenk made some remarks concerning the propagation of fruit trees, particularly the apple, illustrating by a large series of specimens the methods of budding and root-grafting which are used for commercial purposes, and discussing at some length the question of the quality of the root system obtained for the new plant by the various modes of propagation.

Professor F. E. Nipher exhibited some photographic positives on glass, and spoke briefly on the relation between negative and positive in photographic plates, showing that there is a certain relation between intensity of actinic light acting on the plate during exposure and during development, as a result of which a greatly over-exposed plate may be developed into a positive instead of a negative, by allowing access of a limited quantity of light during development, while a plate which has been very briefly exposed may in the same manner be developed into a positive by a proportionate increase in the light allowed to fall on it during development,—a neutral or zero point, in which the plate is completely fogged, being passed in each instance.

Mr. G. Pauls exhibited a number of beautiful caterpillars, the larvæ of *Euphydryas phaeton*, which does not appear to have been hitherto recorded as occurring in Missouri, although Scudder reports it from adjoining states. The food plant on which these were found was a species of *Gerardia.*

Dr. H. von Schrenk exhibited a burl on a branch of Mississippi scrub pine, caused by a rust fungus, *Peridermium cerebrum*, which was in excellent fruit.

Four persons were elected active members of the Academy.

William Trelease,
Recording Secretary.

TORREY BOTANICAL CLUB.

At the meeting on April 10th, the paper of the evening was by Professor F. E. Lloyd, 'Studies in the genus *Lycopodium.*' Professor Lloyd discussed the distinguishing characters of the North American species, with reference to habit, sporangial leaves and their arrangement, leaf-sections and other modifications. Two new species were recognized in this review of the genus. One group of species is remarkable for greater variation here than in Europe, producing five species here and one there; including here *L. inundatum*, *L. alopecuroides*, etc. The type-specimen of *L. pinnatum* of this group was exhibited. These species develop strong, starchy thickening of the growing end of the stem, toward the close of the season, serving as basis of growth the next spring. Professor Lloyd also restored the long-forgotten species *L. Sitchense*, which has five rows of leaves, but has been confused with the 4-rowed species *L. sabinaefolium.*

Dr. Underwood followed, remarking on the general distribution of *Lycopodium*, about 94 species, or perhaps, properly, about 120; of which 12 are North American; perhaps 21 are peculiar to the Andes, and with them grow many others, which extend into Mexico or Guiana; about 8 are peculiar to Madagascar, 4 to India, etc.; mostly in mountain regions. *L. cernuum* probably encircles the world in the tropics. The local distribution along Atlantic America is peculiar; *L. alopecuroides*, reported from New England, cannot be traced by accessible specimens north of Long Island. The sprawling and arching habit of this species, with spongy interior and caterpillar-like or fox-tail like exterior gives it a very peculiar effect. Dr. Underwood also described his discoveries of *L. porophilum*, in Kentucky, Wisconsin, Alabama, etc.

The Secretary raised the question of the distribution of *L. annotinum.* This species is present in the Adirondacks, Catskills and Palisades, and forms compact areas in the Pocono; but has been searched for westward in New York without success.

Dr. Britton spoke of the interest attaching to *L. porophilum* as growing on sandstone rocks. Plants on sandstone rocks which have been attributed to *L. Selago* should be re-examined with this in mind. Still another form on the sandstones of the Shawangunk also deserves further investigation. Miss Sanial reported collecting 5 species in or close to New York City.

Miscellaneous notes followed. Dr. Underwood reported word just received from a club member working in Jamaica who has already collected 200 species.

Dr. Britton referred to a Japanese Witch-hazel flowering April 1st at the Botanical Garden, *Hamamelis arborea*, with thorny, pinkish yellow flowers with dark central eye formed by the claret-colored calyx. It has been cultivated at Kew since 1875.

Dr. MacDougal reported a large number of pictures and documents relating to Dr. John Torrey which are accumulating preparatory to the proposed Torrey Day at the A. A. A. S. meeting, with letters to Torrey from Engelmann, Herbert Spencer, etc.

Edward S. Burgess,
Secretary.

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

AT the last meeting of the Science Club of the University of Wisconsin, Mr. H. L. Russell favored the club with an exceedingly valuable and timely address on 'Some Recent Investigations relative to Communicable Diseases.' Mr. Russell can speak with authority upon this subject and his expression of opinion regarding the efficiency of methods for preventing the spread of diseases and for eradicating them has an especial interest at this time.

Beginning with a brief synopsis of the state of knowledge concerning the nature and life history of the malarial parasite, Mr. Russell discussed the recent researches as to the relation that mosquitoes hold in the propagation of malaria. The establishment of a definite host in which the sexual propagation of the organism of malaria occurs, and a thorough proof of the rôle that this suctorial insect plays in the dissemination of this disease is one of the most brilliant discoveries in biology in recent years.

The discoveries relating to the bubonic plague were then taken up. After discussion of the etiology of the disease and the method by which it is disseminated, the recent methods of treatment including the preventive and curative treatment were presented. It was pointed out that the United States should with a rigorous quarantine escape the bubonic plague since the period required for the organism of the plague to develop in a patient is less than the time required for vessels to reach our shores from infected oriental ports.

Following this a general discussion of the principles underlying the action of therapeutic and prophylactic treatments of different communicable diseases was given embracing the methods of vaccination that result in the production of active and passive immunity in the body of animals as well as of human beings.

WM. H. HOBBS.

DISCUSSION AND CORRESPONDENCE.

A NATIONAL LIBRARY AND MUSEUM OF THE HISTORY OF CHEMISTRY AND COGNATE ARTS AND SCIENCES.

IT is a matter for rejoicing that not only the principal American universities and various institutes, but also a number of professional colleges, among them those of medicine and pharmacy, have accumulated and are in the possession of more or less comprehensive libraries and museums and that they are aiming at their constant enlargement and completion. Such libraries and museums cannot fail to become more and more potent auxiliaries in the educational and literary objects of these institutions as well as an efficient factor for the advancement of American scholarship and culture.

Most of these libraries are of comparatively recent origin and generally embrace the pertinent scientific and professional literature of modern times but rarely contain any considerable amount of works of past centuries. Such older books are scarcely any longer in the book market and are rarely available except by chance as is particularly the case with works that specially relate to the remoter eras of the history of alchemy, of pharmacy, materia medica, spices, etc. Whoever has had experience in the fascinating study in these domains of historical research will be familiar with the difficulty of finding in any one of the great European libraries an approximately complete collection of the extant literature of all ages. There is quite a difference in this respect among the foremost libraries; they are mostly well provided with the general literature of the past, but are more or less deficient in this special domain of historical records. But in the multiplicity of the great book collections, particularly in Germany, libraries specially rich in ancient works relating to the history of materia medica, alchemy and pharmacy are sometimes located in close proximity and even in one city, like the comprehensive historical libraries of the German National Museum and that of the municipality at Nuremburg, the University and the city libraries at Leipsic and the various great libraries in Berlin, London and Paris. Shortcomings of this kind in the various European libraries are of less consequence to the student as the distances in Central Europe are not considerable and as books are distributed on loan by mail by most libraries.

It is, however, different in a younger civilization, and in a country of so vast an extent as the United States, where the prevailing multiplication of libraries, on the one hand, and the increasing scarcity of available books of remoter ages, on the other hand, tend constantly to increase these difficulties. The stock of ancient works in these domains of history is rapidly absorbed by the older standing libraries, and is becoming scarcer and less available from century to century. As these works are of paramount value, and indispensable in historical research and study, it should be the common aim of American scientists interested in the history of applied chemistry, of medicine, pharmacy, and materia medica, to conscientiously gather, preserve and, as much as possible, to unite whatever much or little of such ancient books as has been accumulated in American book collections, with a view of ultimately consolidating the scattered parcels of these literary treasures into one American historical library of chemistry and cognate sciences and arts, instead of leaving them dispersed and screened in a multitude of petty private book collections.

Such a desideratum might be realized by the initiative and joint action of the American Chemical Society, of the American Association for the Advancement of Science, and of the American Pharmaceutical Association, and should be undertaken in time. An excellent and rare chance, perhaps never to become available again is fortunately close at hand. The various university, and other public, libraries may possess some stray volumes of such historical literature, and in the common interest may consent to transfer them to a central historical library of chemical and cognate literature. But the main stock for the foundation of such a library might be obtained, sooner or later, by the acquisition and the consolidation of two collateral historical libraries of superior extent and value, accumulated by individual efforts and means, during many years of unostentatious, patient, and discriminating collecting. They are the comprehensive libraries of Professor H. Carrington Bolton, in Washington, D. C., and of Professor John Uri Lloyd, and Mr. Curtis G. Lloyd, in Cincinnati, O.; the former embracing, especially, the history of alchemy and chemistry, the latter that of materia medica, pharmacy and botany.

By themselves and in the prevailing drift of indiscriminate multiplication of public and private libraries these two choice libraries would, perhaps pass to coming generations as uncommonly valuable yet separate, and fragmentary book collections in a special domain of historical bibliography and would hardly ever attain to a maximum of usefulness. When united and subsequently completed by further additions in the way of purchases, donations and bequests, they will form in the course of years a national historical library of chemistry, and materia medica unequalled in America, and on a par with other kindred achievements of American enterprise and munificence. This would add a potent factor for fostering that 'historical sense' so much appreciated in European civilization and culture and largely needed in the materialistic drift prevailing in our country and time. Nor would American students of the remoter eras of history in these domains of knowledge and application any longer be obliged to resort for historical researches to the libraries of foreign countries.

Another somewhat correlated subject is the collection and preservation of historical articles of all kinds relating to the history of chemistry, pharmacy and materia medica, as well as to objects of remembrance of men eminent in these domains of application. Whoever is familiar with the valuable and interesting historical collections of this kind in the ethnographical and art museums of the European capitals, of the National Museum at Nuremberg, and a number of Continental public and private collections will appreciate their usefulness and significance. How many interesting objects of remembrance of eminent chemists and naturalists of the past are still astray and concealed in family and private custody, perhaps never to be gathered in accessible collections as mementos to coming generations! At the occasion of the annual meeting of the Swiss Pharmaceutical Society at Bern in August, 1898, there was in addition to the customary display of apparatus and implements an exhibit of the miscellaneous objects left by the late Dr. Fred. Flückiger, till 1891 professor of pharmaceutical chemistry and pharmacognosy at the university of Strassburg and one of the foremost scholars and writers in these special domains. It comprised laboratory apparatus, manuscripts, rare books, diplomas medals and various other objects of historical interest and demonstrated impressively the value and usefulness of collections of this kind.

Throughout the United States there is undoubtedly scattered a large number of similar objects and specimens of paramount historical interest and significance left by departed naturalists and students, partly emigrants from European and Central American States, which after the demise of their owners have passed to succeeding generations, perhaps as little understood and appreciated, obsolete relics. Most of such articles, even of more recent American investigators and scholars sooner or later sink into oblivion and frequently are lost. When gathered by purchase, donation or bequest and collected and preserved in one museum they would form a comprehensive collection, valuable and instructive for the history of chemistry and pharmacy as well as of their foremost representative men of the past.

Some such stray relics are to be found in a number of the collections of American institutes and universities, among them in the materia medica collection of the National Museum at Washington. They are the few remaining implements of Joseph Priestley from his kitchen laboratory in Northumberland, Pa., which will be remembered by the surviving American chemists who on August 1, 1874, assembled at that secluded village in the beautiful Susquehanna valley in centennial commemoration of the discovery of oxygen. Many interesting objects from the laboratories and studies, as well as an abundance of documents consisting of books, diplomas, medals, manuscripts, correspondence of American chemists and naturalists of the departing century, now scattered and concealed on the shelves of college museums and in domestic shrines, when gathered and united in a national museum, would at once and still more in time form a memorable and most valuable and interesting collection to which the older generation of still living American chemists and scientists would not fail sooner or later to contribute their share.

In this way an historical library and museum of chemistry and cognate sciences and arts could be realized in the course of time which from the start would bear the impress of a national one and which in interest and value might soon surpass the existing corresponding European libraries and museums.

These random suggestions may be in place and in time at the dawn of a new century. They may also serve as a timely warning to all interested in this matter against dispersing the historical literary treasures and relics of the past and against the untoward multiplication of petty and inadequate historical libraries and collections as met with in the old and not less in the new world.

Fred. Hoffmann.

Berlin, April, 1900.

CEDAR COLLARS OF THE NORTH PACIFIC COAST INDIANS.

Editor of Science: Can any one tell me whether the cedar collars of the North Pacific Coast Indians are made rights and lefts. In Dr. Boas's paper in Report of U. S. National Museum for 1895, on the Kwakiutl Indians there are many examples of the cedar bark collars figured, but it does not appear from the drawings whether they are worn indifferently on the right or left shoulder, that is, whether the ornament is worn on a particular side. The reason for asking is this: The Porto Rican stone collars are rights and lefts. In the National Museum collection of thirty, every one of them is carefully carved to imitate the splice joint shown perfectly in Dr. Boas's examples of cedar bark. In the drama of the expulsion of the Cannibal, acted with so much spirit by these Indians in Chicago, two men led the Cannibal to the fire, each wearing a cedar bark collar. It requires little imagination to transfer this scene to Porto Rico, where stone collars in likeness of those of bark would surround the necks of the captors, one on the right hand, the other on the left, wearing each the decoration outside. I discovered twenty-five years ago that the Porto Rican collars were rights and lefts, also that the overlapping ornament at the side of each stood for the sizing or wrapping of a hoop, but then did not know that Dr. Boas's Kwakiutl Indians were wearing homologous decorations.

O. T. Mason.

HIGHHOLE COURTSHIP AGAIN.

TO THE EDITOR OF SCIENCE: On one of the last days of April I noticed a pair of highholes on the turf about forty feet away. One would drill the turf vigorously a few times, and then nod the beak repeatedly with a sidewise motion to the other—presumably the female, and this one took no part in the turf-drilling. While nothing passed from beak to beak, yet the antic play rather confirmed my somewhat jesting suggestion (SCIENCE, N. S., 1897, 921) that it is a feeding pantomine, the female, like a young bird, being receptive of the feeding attentions of the mate. A thorough study of this interesting bird through a telescope or powerful glass ought to reward the observer.

HIRAM M. STANLEY.

LAKE FOREST, ILL.,
May 7, 1900.

A CORRECTION.

In a note printed on page 753 of SCIENCE (May 11th), I inadvertently appear to advocate the view that the current year belongs to the twentieth century, which is not my opinion. The sentence in question should have read "It seems to me that that is reason enough why we should use '00 always to mean 1800, not 1900, even though the current year belongs to the *nineteenth* century."

E. L. MARK.

THE GRAPHOPHONE AS AN AUXILIARY ASTRONOMICAL INSTRUMENT. A SUGGESTION.

IN order to insure as comprehensive and authentic a graphic record of the appearance of the solar corona, as deliberate and close observation and scrutiny limited to the few minutes of totality can well be expected to furnish, I beg leave to suggest the employment of an ordinary graphophone for taking down the observer's talk instead of a short-hand recorder.

The graphophone if properly set agoing and manipulated will easily record all the observer might choose to say for about three or four minutes, and therefore would enable him to give his undivided attention to the examination and thorough study of the aspect of the phenomenon, without even the risk of being disturbed or interrupted at the critical moments by questions, etc. Nothing, it would seem, could possibly defeat securing by this means a complete and authentic record of all an observer might feel prompted to utter or note, except, perhaps in the case the splendor of the corona should render him temporarily speechless. For verification, if deemed necessary, employ a second graphophone. The time of occurrence of any unexpected event can be noted and recorded upon the rotating barrel in several ways.

A trustworthy and comprehensive graphic account of the physical aspect of the corona and chromosphere, would be valuable I should think, in so far as it would supplement the colorless work of the camera.

W. E.

NOTES ON PHYSICS.

THE BLUE HILL KITE OBSERVATIONS.

MR. H. H. CLAYTON, in an interesting letter to *Nature*, April 26th, points out the bearing of recent observations of temperature and wind velocities at high altitudes upon the theories of cyclonic movements of the atmosphere. Four types of instability of the atmosphere are now recognized: (1) Instability due to heating of the lower strata of the atmosphere (vertical temperature gradient). (2) Instability due to the thrusting of large masses of warm air into cool regions or of large masses of cold air into warm regions, for example, a long continued southerly wind carries a mass of warm air northward into a region in which the surrounding air is cool (horizontal temperature gradient). (3) Instability due to accumulation of water vapor in the lower strata of the air. Such air precipitates its moisture more and more as it rises, is warmed by this precipitation and rushes upwards with increasing violence. (4) Instability of air streams which have passed beyond the region in which they are more or less of the nature of permanent states of motion. Thus the trade and antitrade winds in certain regions show the characteristics of what are called in hydrodynamics *permanent states of motion* and when they pass beyond these regions they become dynamically unstable and break up.

Each of these various types of atmospheric instability has been put forth as the principal cause of cyclonic motion by different writers and Mr. Clayton points out that observations in the high regions of the atmosphere afford criteria for determining which of the four types of instability is most predominant in a cyclone.

The kite observations at Blue Hill seem to show according to Mr. Clayton that the first type of instability is not all important, but it must be remembered that these kite observations do not extend beyond 3000 meters above sea level, and although Mr. Clayton considers also the balloon observations which have been made in Europe, still we think that his conclusion is more or less tentative (as no doubt Mr. Clayton intends it to be) but he seems to lose sight of the fact that the vertical stability theory, No. 1, requires a high pressure area in the higher regions to be directly above a low pressure area at the earth's surface. Thus Mr. Clayton seems to think that the observations of March 24, 1899, showing a low pressure area near the earth's surface in Italy and a low pressure area in the upper air over Finland, is against the vertical instability theory. Further, after a cyclone has been some time under way the upward current near the center of the cyclone would undoubtedly produce a mass of warm air extending to enormous altitudes immediately above the center and that, therefore, the absence of a cold stratum within the range of the observations is not decisively against the vertical instability theory.

Furthermore, the force of Dr. Hann's objection to the preponderating influence of the third type of instability, that cyclones are more frequent and more violent in winter than in summer, is weakened by the fact that our position with reference to the polar and equatorial winds is very different in winter than it is in summer so that the influence of the fourth type of instability is greatly different at these two seasons and may mask the effect of the third type.

The probability is that one type of instability may preponderate in one place or one season and another type in another place or season.

The present writer is inclined to think that as a rule, the first type of instability furnishes the energy of cyclonic movement and that the fourth type determines the line of progress or the path of the cyclone; that the second type of instability is the cause of the local disturbances which occur in the region just ahead of a cyclone such as tornadoes and thunder storms; and that the third type of instability contributes greatly to the violence of these local disturbances.

W. S. F.

APPLIED SCIENCE IN MUNICIPAL WORK.

THE city of Marshalltown, Iowa, has just issued in pamphlet form, the 'preliminary data for the design of a proposed sewage system' which illustrates in an unusually satisfactory manner, the rare case in which municipal authorities have displayed enough of wisdom and of familiarity with the resources of their country to bring to bear upon their problems of construction, the best scientific knowledge available. The committee of the city council applied to Professor Marston, the civil engineer, Professor Weems, the chemist and Professor Pammel, the botanist of the University of Iowa, for advice, and under their direction the data reported were collected. The work of the survey in detail, was done by trained students, largely, and the drawings were made by Miss Wilson. The city of Marshalltown paid all expenses and its officials seem to have heartily seconded the endeavor of the chemists and engineers of the University.

The city has a population of 12,000 and is the county seat of Marshall Co., and the commercial center of a rich agricultural country. There is some manufacturing, the principal shops of the Iowa Central Railroad and large beet-sugar manufacturing establishments being located there. The sewer system contains about ten miles of sewers and laterals. Water is supplied from drive-wells and to the amount of about 1,300,000 gallons per day, the glucose and packing houses taking a large fraction of that used for other than domestic purposes. It contains about 300 parts solid matter in the million, mainly lime and magnesia salts. Deeper wells of artesian character, belonging to the glucose company, show about 900 parts solid matter, of which about two-thirds seem to be lime and magnesia salts and fifteen per cent. organic matter, although the wells are 300 feet in depth. The city water in May, 1899, showed 1040 bacteria per c.c. The sewage is passed into the Iowa River, which flows, at a minimum, about 3,250,000 gallons per twenty-four hours and contamination by sewage is at all times serious. Where thus contaminated, its color is dark, its odor offensive and its mean content of bacteria at times as high as about 100,000 per c.c. and probably more. The outcome of litigation directed against the city by residents of the country below, along the banks of the stream, has been the determination of the city to adopt a system of purification of the sewage and it is to this end that the experts of the University were consulted.

It was promptly discovered that the glucose sewage was very different from that of the city, in respect to content of bacteria, as was to have been expected. Its bacteria ranged up to, in one case, nearly ten millions per c.c. While not unwholesome when fresh, it is subject to putrefaction of a seriously objectionable character. The packing-house sewage also contains large quantities of bacteria and has a characteristic composition. The result of intermixture of these various kinds of sewage is a peculiarly offensive and troublesome compound.

In seeking the best remedy for this state of affairs at Marshalltown, the data printed in the report were gathered. The work included a study of the topography of the country, of the character of the soil, the available materials for construction, of filtering and settling tanks and the costs of labor and material. It is stated that the works should be completed before November of the present year.

In the performance of the work of the consulting chemists and bacteriologists, the methods of the Massachusetts Board of Health were usually followed.

R. H. THURSTON.

'*ARROWPOINTS, SPEARHEADS AND KNIVES OF PREHISTORIC TIMES.*'

UNDER the above title, Professor Thomas Wilson, Curator of the Division of Prehistoric Archæology of the U. S. National Museum, occupies pages 811 to 988, of the Report of the Museum for 1897. Sixty-five plates and two hundred and one text figures accompany the paper. The whole is also run by the Government Printing Office, as a reprint bearing the date 1899.

Much material is brought together in this paper, besides copious references to the literature and sources of information. The chipped objects of the palæolithic period are touched upon, and sections are devoted to the origin, invention and evolution of the bow and arrow; superstitions concerning arrowpoints; flint mines and quarries of Europe and America; caches; material for points and its microscopic examination; the manufacture of points; and scrapers, grinders and straightners used in making shafts for arrows and spears. Fifty-seven pages and a proportional number of plates and figures are devoted to Mr. Wilson's classification of points for arrows and spears which is under the four main divisions, leaf-shaped, triangular, stemmed and peculiar forms. Knives and wounds made by points are also discussed. Flint mines and quarries, caches, large implements and the making of arrowpoints described by explorers and travelers are the subjects included in appendices A, B, C and D.

Some of the illustrations are familiar to readers of archæologic literature, who are glad to have them brought, together with the new illustrations, under one cover.

The manufacture of arrowpoints was seen as late as the summer of 1898 by several members of the Jesup North Pacific Expedition in the Thompson Valley, British Columbia, but in a few years it will be an industry of the past, at least in regions accessible to the body of students of archæology. Dr. Wilson has introduced a number of quaint pictures of a flint knapper engaged in chipping gun flints at Brandon, Suffolk, England.

HARLAN I. SMITH.

DIETARY STUDIES OF UNIVERSITY BOAT CREWS.

PROFESSOR W. O. ATWATER and Mr. A. P. Bryant have prepared an interesting bulletin on the above subject, published through the Office of Experiment Stations, U. S. Department of Agriculture. Their results, together with the comparison of other dietary studies, are summarized in the following table:

TABLE SHOWING NUTRIMENTS IN FOOD ACTUALLY EATEN PER MAN PER DAY.

	Protein.	Fat.	Carbo-hydrates.	Fuel value.
DIETARY STUDIES OF UNIVERSITY BOAT CREWS.	Grams.	Grams.	Grams.	Calories.
Harvard University crew at Cambridge (No. 227)	162	175	449	4,130
Harvard Freshman crew at Cambridge (No. 228)	153	223	468	4,620
Yale University crew at New Haven (No. 229)	145	170	375	3,705
Harvard University crew at Gales Ferry (No. 230)	160	170	448	4,075
Harvard Freshman crew at Gales Ferry (No. 231)	135	152	416	3,675
Yale University crew at Gales Ferry (No. 232)	171	171	434	4,070
Captain of Harvard Freshman crew (No. 233)	155	181	487	4,315
Average	155	177	440	4,085
SUMMARIZED RESULTS OF OTHER DIETARY STUDIES.				
Football team, college students, Connecticut	181	292	557	5,740
Football team, college students, California	270	416	710	7,885
Professional athlete, Sandow	244	151	502	4,460
Prize fighter, England	278	78	83	2,205
Average of 15 college clubs	107	148	459	3,690
Average of 14 mechanics' families	103	150	402	3,465
Average of 10 farmers' families	97	130	467	3,515
Average of 24 mechanics' and farmers' families	100	141	429	3,480
Average of 14 professional men's families	104	125	423	3,325
DIETARY STANDARDS.				
Man with moderate muscular work, Voit	118	56	500	3,055
Man with moderate muscular work, Playfair	119	51	531	3,140
Man with moderate muscular work, Atwater	125	....	....	3,500
Man with hard muscular work, Voit	145	100	450	3,370
Man with hard muscular work, Playfair	156	71	568	3,630
Man with hard muscular work, Atwater	150	....	....	4,500
Man with severe muscular work, Playfair	185	71	568	3,750
Man with severe muscular work, Atwater	175	....	....	5,700

LAKE LABORATORY OF THE OHIO STATE UNIVERSITY.

THE Lake Laboratory of the Ohio State University was established under the direction of the late Professor D. S. Kellicott, for the especial purpose of providing opportunity for investigation of the biology of the lake region, and investigations have been carried on each summer since its establishment except for the summer of 1898, when the death of Professor Kellicott interrupted the work. It has now been determined to add to the original purpose the provision for giving certain courses of instruction and to combine work of the departments of botany and zoology. The following statements concerning the plans for the summer of 1900 are made for the benefit of those who may wish to work at the laboratory, either in independent investigations or in connection with the courses of instruction offered.

The staff includes the regular instructors in the departments of Botany, Zoology and Entomology.

HERBERT OSBORN, Professor of Zoology and Entomology, *Director*.

W. A. KELLERMAN, Professor of Botany.

JAMES S. HINE, Assistant Professor of Entomology.

J. H. SCHAFFNER, Assistant Professor of Botany.

F. L. LANDACRE, Assistant in Zoology.

The laboratory is located close to the waters of Sandusky Bay, which teem with animal and plant life, while extensive marshes, the river, native forest, beach and lake are all within easy reach. Put-in-Bay with the United States Fish Hatchery, Kelley's Island with its glacial grooves, and other points of natural interest are easily reached by excursions and will be visited in collecting or special trips. The fishing industry centering at Sandusky, affords special opportunity for study and investigation in ichthyology.

The laboratory is housed in the former State Hatchery building which has been arranged with tables, dark room, aquaria, etc., and is supplied with microscopes and other apparatus from the university. Boats, collecting apparatus, dredges, seines, etc., are well supplied and special attention will be given to the methods of collecting and field work.

The courses of instruction will open July 2d, and run eight weeks. Five days each week will be devoted to regular exercises and one day left open for individual or special excursions.

Following the plan which has been in operation for several years past, the laboratory will be open to properly qualified persons who may desire to engage in investigations of biological problems pertaining to the life of the locality. No fees will be charged and table room, use of ordinary reagents, boats, aquaria, etc., will be supplied, subject only to such provisions as may be necessary to make the facilities equally available to all. Each investigator will be expected to furnish his own microscope, cutting instruments, and special apparatus or reagents needed in his investigation unless otherwise arranged.

The laboratory will be open for investigators from June 15th to September 15th. Applications for table room should be made as early as possible with indication of the time during which space will be desired.

SCIENTIFIC NOTES AND NEWS.

THE bill for the establishment of a government biological station on the coast of North Carolina has become a law. The sum of $12,500 is appropriated for the construction and equipment of the station, which, it is understood, will be located on Beaufort Harbor.

THE Senate Committee has made a report on the Nicaragua Canal bill, favoring the provision by Congress of money to construct the canal after having secured authority from Nicaragua. The proposition to buy the works by the French on the Panama route was rejected.

THE House Committee has submitted a favorable report on the measure now before Congress designed to prevent the adulteration, misbranding and imitation of foods and drugs. The bill would create a chemical bureau under the U. S. Department of Agriculture.

A COMPLIMENTARY dinner was given on May 15th to Professor Wilder D. Bancroft, of Cornell University, by his associates and pupils in the department of physical chemistry. The occasion was the fifth anniversary of the inauguration of the department. Speeches were made by Professor E. L. Nichols, Professor J. E. Trevor, and others; and many messages of congratulation were received from friends and old associates of Professor Bancroft in other universities.

PROFESSOR C. A. YOUNG, director of the Halsted Observatory, Princeton University, will give a commencement oration at Western Reserve University. Professor Young was professor at Western Reserve University before going to Dartmouth and Princeton. During the commencement there is to be an informal opening of the new telescope, which has been given to the university by Mrs. W. R. Warner and Ambrose Swasey, of Cleveland.

DR. EDUARDO WILDE, the new minister to the United States from Argentina, was formerly minister of Public Instruction and is known for his studies in yellow fever.

MR. W. E. D. SCOTT, curator of the ornithological collections of Princeton University, has returned from a visit abroad where he has been studying the ornithological collections in London and Paris with a view to his monograph on the Patagonian birds collected by Mr. J. B. Hatcher.

A DINNER was given in London on April 28th to Sir W. MacCormac and Mr. Trevors to celebrate the occasion of their return from South Africa.

JAMES M. CONSTABLE, Vice-President of the American Museum of Natural History, died on May 12th, at the age of eighty-eight. Mr. Constable was born at Stonington, Sussex, England, but came to New York in 1836.

THE death is announced at the age of 77 years of Professor Wenzel Hecke, formerly a member of the faculty of the School of Agriculture, at Vienna, and of Dr. Bernhart Nöldeke, assistant in the zoological laboratory of the University of Strassburg.

LIEUTENANT-GENERAL A. H. LANE-FOX PITT-RIVERS, F.R.S., died on May 4th, at the age of 73 years. He had a distinguished military career, but was best known for his work in anthropology and archæology. The London *Times* states that he was only 25 when he began to collect specimens of objects such as weapons, articles of dress, ornament, etc., which were brought to England from various savage countries. In choosing his specimens he was guided by the principle of connection in form, his desire being to illustrate the development of specific ideas among savage peoples and their transmission from one people to another. The result of his patience and scientific enthusiasm was the formation of a collection illustrative of savage life and embryo civilization which is certainly unrivalled in England and probably in Europe also. It was exhibited in 1874 and 1875, in the Bethnal-green Museum, and afterwards General Pitt-Rivers presented it to the University of Oxford, which gave it a home in the new Museum-buildings, opposite Keble College. In 1880 the General, who had up to that time borne his father's name of Lane-Fox, succeeded to the Rivers estates under the will of his great-uncle, the last Lord Rivers, by which also it was provided that he should assume the name and arms of Pitt-Rivers. From the point of view of the interests of science it would have been difficult to find a better heir for these unique estates. Lying in Wiltshire, near the Dorset border, they had remained, for the most part forest land, containing numerous herds of fallow deer, practically untouched until the present century. They thus presented an unique field for excavation under trained archæological guidance, and General Pitt-Rivers made full use of the opportunity which fortune had placed in his hands. His excavations in the barrows, etc., round Rushmore were extensive and continuous, and the results of them he described in several large volumes which are constantly cited by archæologists. He has contributed a good deal of valuable material to the 'Reports' of the British Association and to the *Journal* of the Anthropological Institute, of which body he was president. At the Oxford Encænia of 1886 he received the honorary degree of D.C.L.

DR. FRITZ SHOTTKY, professor of mathematics at Marburg, has been elected a member of the Academy of Sciences of Berlin.

THE Academy of Sciences of Madrid has awarded its mathematical prizes to G. Loria of Genoa, and F. G. Teixeira of Oporto.

DR. KARL E. GUTHE of the department of physics of the University of Michigan, sailed on May 17th for Europe, where he will spend the summer in special study of the coherer and of polarization. He will read a paper on 'The Theory of the Coherer' at the meeting of the International Congress of Physicists in Paris August 6–11th.

MR. H. F. SILL of the chemical department of Princeton University, has been given leave of absence for two years and will study at Heidelberg and Munich.

WE learn from *Nature* that a committee composed of many eminent men of science in France has been formed for the purpose of obtaining funds for the erection of a modest monument at Langres in honor of Auguste Laurent, the renowned chemist. Laurent was born at La Folie, near Langres, in 1808, and in 1831 became assistant to Dumas under whom he acquired a special knowledge of organic chemistry, and carried on his original researches on naphthalene and carbolic acid, together with their derivatives. After filling various posts, the last of which was a chemical professorship at Bordeaux, Laurent became Warden of the Mint at Paris, where he remained in intimate connection with Gerhardt until his death in 1853. Subscriptions for the proposed monument should be sent to the treasurer of the Committee, M. Caublot, 45 rue de Belleville, Paris.

THE German Society for Advancing the Teaching of Mathematics and the Sciences meets this year at Hamburg from June 4th to 7th.

THE Society of Zoology and Botany at Vienna proposes to celebrate the fiftieth anniversary of its foundation in April, 1901, and to prepare for the occasion a *Festschrift* setting forth the history of the Society and in general the part played by the natural sciences in the advances of the past fifty years.

In 1833 General Arakezeyew bequeathed to the Russian Academy of Sciences the sum of 50,000 roubles which were to accumulate till 1925, when three-fourths of the sum should be given to the best history in Russian of Alexander I.'s reign. The other quarter was to be spent in printing the work, in having it translated into French and German, and for a prize to the second best work. It is said that the fund now amounts to 1,500,000 roubles and would in 1925 consequently be in the neighborhood of $1,500,000.

At a meeting of the members of the Royal Institution on May 7th, thanks were given to Professor F. Clowes for his donation of £20 to the fund for the promotion of experimental research at low temperatures. The following vice-presidents for the ensuing year were announced from the chair: Sir F. Bramwell, Lord Lister, Dr. Ludwig Mond, Sir A. Noble, Mr. A. Siemens, the Hon. Sir J. Stirling, Sir J. Crichton Browne, treasurer, and Sir W. Crookes, honorary secretary.

A society at Gera, Germany, offers prizes for essays calling attention to the need of protection of plants by the young. It is proposed to circulate the essays widely through the schools.

The University of Zurich offers a prize for an essay on the use of alcohol in acute diseases.

Sigmi Xi, the Scientific Society corresponding to Phi Beta Kappa, has established a chapter at Brown University with Professor B. F. Clarke as president.

Under the direction of Captain J. F. Pratt, of the United States Coast and Geodetic Survey, preparations are being made to despatch the United States steamers *Pathfinder* and *Patterson* to Behring Sea early next month, where they will be engaged during the season in surveying the coast of Alaska between St. Michael and Cape Prince of Wales.

Professor Linck, director of the mineralogical laboratory at Jena has undertaken a scientific expedition to the Soudan.

Reuter's Agency learns that Dr. Louis Sambon and Dr. G. C. Low, who, as we have already reported, are about to experiment with a view to proving that malaria is spread by mosquito bites, expect to begin work seriously on June 1st, by which time they would have all their arrangements completed. They were leaving London immediately. They had hit upon a suitable spot in the Campagna, on the line of the railway running from Rome to Tivoli, and there they would begin their work. Their house would be put together at a spot about a mile from the little station of Cervellata, 30 minutes' run by rail from Rome, where a colony of Lombards were trying to reclaim that part of the Campagna. So far as malarial conditions were concerned no place could be worse.

The New York *Evening Post* contains the following note: "Commander Chapman C. Todd, chief hydrographer of the Navy, has been suspended from duty by Secretary Long, pending an investigation by the department into a charge that he had endeavored to influence the action of Congress in a matter affecting the naval service. The suspension grew out of the controversy in Congress over the reduction by the House Committee on Appropriations of the appropriation for surveys to be conducted by the Navy, and the refusal of the committee to agree to turn over the surveys of the insular possessions of the United States to the naval service. Commander Todd is one of the best known officers of the Navy. He commanded the gun-boat Wilmington in the Spanish-American war, and was in charge of the operations at Cardenas in May, 1898, in which Ensign Worth Bagley and some enlisted men of the torpedo boat Winslow were killed. After the war he made a cruise in the Wilmington up the Amazon River, penetrating to regions where no foreign vessel had ever been."

A telegram was received at the Harvard College Observatory, on May 14th, from the Arequipa station of this Observatory, stating that the correction of the ephemeris of Eros. computed by Mr. Daniel N. Jones, Jr., is zero, In the Bulletin issued on April 29th, and published in this Journal, it will be noticed that the correction to this ephemeris is almost exactly half the diurnal motion of Eros. Professor Kreutz accordingly cabled that so large a correction seemed improbable and that perhaps an error of twelve hours had been made. A cablegram was accordingly sent to Arequipa and in a few hours a reply was received stating that the correction was zero. The error perhaps arose from assuming that the ephemeris was computed for noon instead of midnight. Attempts were made both visually and photographically to verify this conclusion, but without success, owing to the proximity of the sun.

THE orange groves of southern Florida have enjoyed favorable conditions during the past winter and are expected to supply about one million boxes. Should there be no frost next winter the groves will be again in good condition and the abundant supply of oranges of ten years ago may be expected.

THE annual banquet of the Royal Academy, London, took place on May 5th, with the president, Sir E. J. Poynter, in the chair, and as usual on such occasions the company included many of the most distinguished Englishmen. Sir Norman Lockyer replied to the toast on behalf of science and said, according to the report of the London *Times:* It is a very great honor for a student of science to be called upon in such an august assembly as this to say a few words; but if I am to be accepted as the representative of science I do not wish to be fettered by your suggestion, Sir, that I should refer to the dependence of art on science. I am sure that I may frankly say for every man of science that we acknowledge freely the firm brotherhood between art and science—a brotherhood founded upon a common object, the study of Nature, 'the mistress of the masters,' and carried on by a common method, the proper coordination of brain, hand and eye. In every case which a man of science or a man of art has to tackle imagination is required, and so science and art meet upon terms of mutual helpfulness. I think I may also say that this feeling is thoroughly reciprocated by men of art, for many of them honor me with their friendship, and therefore I know their sentiments. I am the more anxious to say this because some twenty years ago, when I was privileged to attend this anniversary dinner, I heard a distinguished representative of literature express a totally different sentiment. He told me that 'before their sister, Science, now so full of promise and pride, was born, there were Art and Literature like twins together,' and it was suggested that the sooner art and literature formed an alliance offensive and defensive against the interloper the better it would be for them. I do not believe in this. For me science is as old as art. They have both advanced together. Let us take the position of things 6000 years ago—to begin at the beginning of things, if we can. Then the priest-mummifiers of Memphis had to be profound anatomists. If you go to the Gizeh Museum you find magnificent specimens in those statues of Chepren in diorite, other statues in wood, and the plaques, veritable Memlings in stone. If you come down to a comparatively modern period, something like 600 B. C., and compare those wonderful metopes of Solinunto with the marbles of the Parthenon, which are of a later date, you will find an enormous advance in the latter. You will find that Hippocrates had lived in the interval. And, carrying the matter down to the introduction of the University system in Northern Italy in the 13th century, we find that the difference between the art of Cimabue and Giotto depends on the fact that anatomy had been introduced in the meantime. Science, then, is no new interloper seeking to detract from the importance of art and literature. What was new 20 years ago was that the work of the late Prince Consort, whose name will always be revered by those who know the benefits he conferred on our country was then beginning to tell. He showed us that in order to secure individual progress we must have a combination of science and art both in teaching and manufacture. Being well assured of the valor and endurance of our soldiers and sailors in war, the chief thing we have to do is to see that they are properly supplied with the engines and munitions of war. For the beauty of a nation's life and a perfect record of it we must look chiefly to the sweetening and ennobling influences of art and the enduring works of its masters; but for a nation's continued welfare and progress both science and art are necessary. We are in face of industrial struggles, and we must utilize both science and art to supply the wants of our own and other countries, and to provide commodities made in England, besides handling

> "Things of beauty, things of use,
> That one fair planet can produce,
> Brought from under every star."

We are in face of a struggle for existence in which we know full well that only the fittest will survive. How are we going to carry on the struggle? What are our weapons? Our first line of defence in this direction can only consist of our universities and our teaching centers. Have we enough of them? We know already that we have not enough of them, because we have already lost several important engagements in these industrial battles. Are there no means by which we can judge of their sufficiency? In those less peaceful struggles among nations which must sometimes arise we have a first line of defence of another kind—our Navy. In that case we have the well-understood and generally acknowledged principle that our fleet must be equal to the fleets of any two other possibly contending nations. This principle, I think, should be applied to our first line of defence in these industrial conflicts the results of which are more enduring. Do our teaching and research centers at present outnumber in the same proportion, as do our ships, those of any two nations which are actually contending with us in peaceful enterprise? And, also, are they equally efficient in every respect? I believe, and I know that this view is held by many representative men of science, that until our universities, our science schools, our art schools, and our technical institutions bear the same relation both in number and efficiency to those of other nations as do our battleships, cruisers, and small craft, we shall not be justified in regarding the future of the empire with that freedom from care which is the attribute of a strong man armed.

UNIVERSITY AND EDUCATIONAL NEWS.

Mr. James Milliken of Decatur, Ill., has offered $200,000 and land for the establishment of a college under the auspices of the Cumberland Presbyterian Church of that place. It is said that the citizens will give over $100,000 toward the college.

New York University has received $20,000 and Rutgers College $10,000 by the will of the late Robert Schell of New York.

A scholarship in New York University has been endowed with $2500 by Dean and Mrs. Edward R. Shaw in memory of their son, a member of the class of 1900, who died last year.

The Ohio Institute of Mining Engineers has undertaken to defray the cost of a scholarship of $100 annually at the School of Mines of the Ohio State University.

The first meeting of the Court of Governors of the Birmingham University was convened for the 31st inst. The donations to the endowment fund which have already been promised amount to $327,000.

At Harvard University Dr. R. DeC. Ward has been promoted to an assistant professorship of climatology, and Mr. W. C. Sabine to an assistant professorship of physics.

The following promotions have been made in the Philosophical Department of the University of Michigan: Mr. George Rebec, Ph.D. (Michigan), instructor in philosophy, to be assistant professor of philosophy; Mr. W. B. Pillsbury, Ph.D. (Cornell), instructor in psychology, to be assistant professor of philosophy and director of the psychological laboratory.

George H. Ling, now instructor of mathematics at Wesleyan University, has been appointed a professor at the Cincinnati University.

Professor Pierre de Peyster Ricketts has resigned from the chair of analytical chemistry of Columbia University.

Dr. August Töpler, professor of physics at the Technical Institute of Dresden, will retire on the first of October.

Dr. Franz Kossmat, assistant in the Austrian Geological Survey, has qualified as docent in the University of Vienna, and Dr. Paul Ehrenreich as docent in ethnology at Berlin.

Dr. Arthur Wreschner has qualified as docent for philosophy and psychology at Zurich. The subject of his inaugural address was 'The Influence of Leibnitz on pre-Kantian Psychology and Æsthetics.'

SCIENCE

FRIDAY, JUNE 1, 1900.

CONTENTS:

*THE LANGUAGE OF HAWAII.**

I.

ENGAGED in the work of geodesy and astronomy, the author of this paper made several trips to the Hawaiian Islands. Although little attention could be given to ethnological or linguistic studies on account of professional duties, contact with the natives incidentally brought out points which seemed interesting.

Struck by the occurrence of peculiar grammatical forms, and finding unusual mental habits among the Kanakas induced by their ethical ideas, it was thought worth while to briefly note these facts. Parallels have been drawn between Polynesian and European constructions, and, as bearing on the formation of language, some incidents are related illustrating characteristic lines of thought.

Grateful acknowledgment is here made to Dr. Cyrus Adler of the Smithsonian Institution, for valuable suggestions as to the arrangement of the material.

I.—INTRODUCTION.

Geographical Limits of Languages considered.—The establishment of the Oceanic family of speech has been characterized by Max Müller as one of the most brilliant discoveries in the science of language. Both on account of the wide geographical limits involved and the scanty basis of com-

*Read before the Philosophical Society of Washington.

parison, a study of these groups is beset with difficulties. Think of the immense space and time separating the localities and occurrences. From New Zealand on the south to Formosa on the north; from Easter Island on the east to Madagascar on the west, covering a territory of 208° of longitude and 88° of latitude—nearly one-fourth the habitable surface of the globe—we find a root language governed by the same grammatical system and pervaded by the same modes of thought. We shall have occasion later to point out certain peculiarities which are common to all the Oceanic languages, but which are radically distinct from any branch of the Indo-European family, showing that Oceanic speech, in the great struggle of the race to acquire an instrument of analysis, has been developed from a fundamental, separate type, and in its origin had nothing in common with the stock to which European tongues are referred. Between some of the islands there has been no contact for thousands of years; yet their linguistic connection is unmistakable and everything points to derivation from a common source. They have the same customs and mythology; the laws of euphony regulating the change from one consonant to another are fixed and uniform; the mold into which sentences are cast, the co-ordination of phrases, the mutual dependence of ideas, all reflect the thought habits of an identical race.

Classification of Oceanic Languages.—The Hawaiian is one branch of the Polynesian group of the great Oceanic family. An analysis of the structure shows that six groups can be logically defined, namely, the Polynesian, Micronesian, Papuan, Australian, Malayan, and the Malagasy. Each one of these embraces distinct branches, having close affinities with one another. For example, the Polynesian includes the language of Hawaii, Fiji, Samoa, Marquesas, and Tahiti. The Micronesian comprises the Gilbert, Marshall, and Caroline Islands; and so on through all the members of the family, ending with Madagascar, which is the center and type of the Malagasy group. When we consider that this vast territory of speech, from America on the east to Africa on the west, with its families, groups, branches, and dialects almost numberless, has been reduced to a permanent and philosophical system of syntax, we do not wonder that one of the most profound students of comparative philology refers to the achievement as a discovery of the greatest importance.

Dispersion of Terms.—Before passing to an analysis of Hawaiian speech, one word on the theory of dispersion. It is admitted that all the Oceanic languages were derived from one very ancient tongue, now lost. The Malagasy has felt the influence of the Arabic, and the Malay shows unmistakable contact with the Sanskrit; yet the great tidal wave of emigration, which was ever from west to east in the Pacific, swept on and preserved intact the structural features of the original form. The theory that each dialect has an indigenous base, and that words common to all were introduced through commercial intercourse, is entirely inadequate. In the first place, the connection was far too slight to produce the effect mentioned, and in the next place the common words are not those ingrafted and absorbed by intercourse, but are such as are in every known language—the oldest and the commonest. When the Normans came to England they introduced many words; but they could not displace those simple names of natural objects as sun, moon, etc., nor those indicating intimate family relations, such as father, mother, brother, sister—terms always dear to the heart of humanity and jealously guarded against foreign intrusion and corruption. Just so in the Pacific. The words common to all branches of the group are those which from the very nature of things must have been in use from time immemorial. This fact alone explodes the theory that the dispersion of terms was the result of intercourse. It is confidently believed by some philologists that the old Egyptian word *ra* (the sun) is still preserved in the *la* of Hawaii, as in Hale-a-ka-la, meaning the house of the sun ; *l* and *r* are still interchangeable in Hawaii, and the word being not only one of the commonest, but also associated with certain forms of worship, has tenaciously held its place through all the varying influence of ages.

The original home of the Polynesian race was one of the Malay islands—probably Sumatra—and the modern Hawaiians exhibit the primitive state of civilization in those islands ; but the dialects have diverged. The Philippine islands now offer the purest type of speech, since here may be found all the grammatical forms which appear more or less complete in the other groups. These islands, therefore, hold the same linguistic place, compared with sister groups, that we find exemplified by Tours in France, Valladolid in Spain, and Hanover in Germany. By some mysterious law of nature these sections have kept their speech nearer the standard, and may be fairly designated as the purest type of the common language.

Introduction of Spanish Words.—One of the most potent factors in the modification of language is commercial intercourse. Similarity has been noticed between certain Hawaiian words and those of identical meaning in Spanish. They furnish evidence of early contact between the two nationalities. Here are a few examples :

The words *mate* in Kanaka and *matar* in Spanish both mean *to kill; poko* in Kanaka means the same as *poco* in Spanish ; *piko* means the same as *pico* in Spanish, as in *ka piko o ka mauna.*

Where do these native words come from? Does the following offer an explanation?

An old tradition relates that in the reign of Kealiiokaloa a foreign vessel was wrecked on the south shore of Hawaii. The only persons saved were the captain and his sister. They were kindly received by the natives, intermarried with them, and became the progenitors of well-known families of chiefs. Counting back through well-established genealogy and allowing thirty years to a generation, the wreck must have taken place between 1525 and 1530.

Three Spanish vessels left Mexico on October 31, 1527, bound for the Molucca islands, in the East Indies. Two of them were lost. No other white people were navigating the Pacific at that period, and it seems reasonably certain that the wrecked vessel was one of the three sent out by Cortez. Their westward course lay to the southward, and the violent *kona* storms of the Pacific would carry them toward Hawaii. On the return trip they went north to latitude 30°, to take the westerly winds, and thus passed far above the islands. This explains why Hawaii, although known to the Spaniards, was seldom visited by them. Old charts in the archives at Madrid show conclusively that the Hawaiian islands were known during the sixteenth century. This bit of history and tradition may possibly explain similar terms in Spanish and Kanaka, of which there are many. On the island of Hawaii may be found at the present day an apparently full-blooded Kanaka child, with pure South Sea features, yet possessing a white skin and a complexion similar to that sometimes seen in the Spanish-Moorish mixture. Will any one say that this may not be a recurrence and manifestation of certain influences in times past? Examples are not wanting in our own race where effects appear after having lain dormant for generations.

II.—PHONOLOGY.

Vowels and Consonants.—Let us now examine the language from the standpoint of sound. The Kanaka ear is as delicate in detecting vowels as it is dull in the distinction of consonants. When Isaac Pitman invented phonography he used the straight line and parts of a circle to represent the English consonants. They were classified into labials, dentals, gutturals, liquids, etc., and the same signs, made heavy or light, were applied to different sounds of the same class. Now it happens that his classes are precisely those in which the Polynesian ear makes no distinction. For instance, with the labials *p* and *b*, we may say either *taburoa* or *kapuloa;* we may say *Honorourou* or *Honolulu*. As a matter of fact, the first form is invariably found in the earlier accounts of the islands. Ask a Kanaka which is right, *taburoa* or *kapuloa*, the reply will invariably be that his ear detects no difference. The term means *great taboo* and is used now as an injunction against trespass. This shows that the Hawaiians, in their inability to distinguish between *b* and *p*, *d* and *t*, *g* and *k*, *l* and *r*, and *v* and *w*, are following a natural law of human utterance, namely, that certain sounds similarly made readily coalesce, and without impairing the context may be used interchangeably. The fact also became evident when the problem of writing English phonographically was confronted. In phonographic characters, *p* and *b* have the same length and slope. They only differ in shading, a detail of minor importance, since the substitution of one sound for the other in the spoken word involves little uncertainty in the meaning.

Two invariable rules lie at the foundation of all Polynesian speech. Every word must end in a vowel, and no two consonants can be pronounced without at least one vowel intervening. Only one word has ever been printed in Hawaiian with two consonants together. That word is *Kristo* Christ. But any number of vowels may be pronounced consecutively, as in the word *hooiaioia* meaning certified, where we have eight continuous vowel sounds. Compare this with the English word 'strengths,' where we have nine letters and only one vowel. Before attempting the pronunciation of this word an Hawaiian would have to transform it by the introduction of at least eight vowels. No less would suffice to make it utterable by Polynesian organs of speech, and the probability is that many more would be interjected in the hopeless struggle to give birth to such an angular product of English speech. Take also the expression, *E i ae oe ia ia*, meaning *Speak thou to him there*. This is a complete sentence of six words in which not one consonant appears to mar euphonic beauty or to disturb the easy liquid flow of vowels so dear to the Hawaiian ear.

The importance of the vowels in the Polynesian languages is such that if we open a Hawaiian dictionary we find, not the order of letters given in English, but a totally different one. First come all words beginning with the vowels *a e i o u;* then those beginning with the consonants *h k l m n p w*. This completes the list of all pure Hawaiian sounds—twelve in number. Nine additional consonants, *b d f g r s t v z*, have been introduced from foreign tongues, because new words took root in the language. In passing, we may say that the Hawaiian consonants are probably the softest and most effeminate of the Oceanic group. In a dictionary of 502 pages, 111 were found devoted to the vowels, 387 to the native consonants, and 5 to the foreign ones, so that the words introduced are about one per cent. of the total number.

Cacophony.—There is a natural aversion in most languages to the consecutive repetition of the same sound, and especially so between words. An example is given on a following page, under 'syntax,' of affirmation by means of the article *he*. The phrase *he pono ole*, however, is never pronounced as written, the *o* is elided, and we say *he pon ole*, just as the Spaniards in rapid speech use *boca bajo* instead of *boca abajo*. So strong is this sentiment that rules of gender are sometimes made to give way so that euphony may be preserved, and the method observed in Italian finds application in Hawaii. Instead of saying *na alii*, the chiefs, the Kanakas drop a letter and say *na' lii*. The Italians say *bel originale*, avoiding the repetition of *o*; the French use *mon amie* and the Spanish *el agua*, in order to eliminate the same disagreeable effect. In English the combination is equally distasteful and we say *an apple*; yet the Hawaiians do sometimes violate this rule in the middle of words. Notice the artifices employed in the different languages to avoid cacophony. The Kanakas prefer elision; the French and Spanish are willing to break another rule of speech in order to satisfy the ear, and couple words of opposite genders, while English avoids the difficulty by supplying a letter. The methods employed exemplify characteristic national traits. The Hawaiian accomplishes his purpose in any way that diminishes labor; he therefore cuts out rather than introduces. The energy of the Anglo-Saxon prompts him to interject something, and the Latins, true to their natural instinct, sacrifice symmetry of form to euphony of sound.

The Guttural Break.—Besides the Hawaiian sounds previously cited there is a guttural break which represents the elision of the *k* in other Polynesian dialects. It is indicated by a comma, just as the circumflex accent in French indicates the suppression of a letter or syllable in earlier forms. This break is an essential part of the word, and a disregard of it completely changes the meaning. For example, *ao* means light; *a'o* means to teach; *ia* means he; *i'a* means fish. There are many examples of this in the language.

As we pass from Sanskrit to Gothic, and on to high German, a regular mutation in the appearance of certain consonants is found. No less evident than this law of Grimm is the change of Polynesian sounds, and, although neither rule is infallible, both are useful in tracing certain paths of development.

The *l* in Samoan becomes *r* in New Zealand and returns to the original letter in Hawaii. The *p* in Samoan is *b* in Tongan, and is again *p* in Hawaii; *v* in Samoan is *w* in New Zealand, but remains *w* in Hawaii. The *k* in New Zealand is replaced by the guttural break in Tahiti and Hawaii. The vowels, however, undergo fewer changes than the consonants.

Meanings of aa.—The definition of words by context necessarily finds wide application in the stage of development now reached by the language of Hawaii. The sound indicated by the letter *a* is probably the most common in the entire range of articulation. Standing alone, it has, like many others, a variety of meanings; but doubled, it answers to nearly thirty significations, many of them of the most diverse nature. To begin with, *aa* may be either a verb, adjective, or noun, and some of its meanings are:

> *to burn, to tempt, to defy, to girdle, to make a noise, to send love.*

Then it may mean—

> *spiteful, silent, stony, mischievous.*

And finally it stands for—

> *fire, belt, dumbness, roots of trees, pocket, bag, dwarf, lava, covering for the eyes, bird of prey, caul of animals, sea breeze at Lahaina, husk of the cocoanut, chaff, outside of seeds or fruit, red fish.*

Add to these some adjectives that may be derived from verbal meanings and the number may be considerably increased. It is evident that a necessary condition for the successful employment of a word of such unlimited power is great flexibility of construction. The groundwork of the language must be free from intricate forms of syntax.

Used alone *a* may be a noun, an adverb, a conjunction, a preposition, an interjection, a verb or an adjective. Under each part of speech it has several meanings. Here are a few when it is used as a noun: First, *the jawbone;* second, *an instrument made of smooth bone, used in piercing unborn infants;* third, *broken lava;* fourth, *white spots in poi;* fifth, *a sea bird;* sixth, *a small fish;* seventh, *the alphabet.*

III.—MORPHOLOGY.

General Characteristics.—We now proceed to develop the peculiar genius of the Polynesian languages, and of the Hawaiian in particular. They differ radically from the Indo-European family, which stands preeminent for the perfection of its organic structure, in three essential particulars:

1. They are completely devoid of inflections.

2. The vowel sounds largely predominate.

3. The construction has great flexibility.

Most writers on the subject fall into the naural habit of comparing the Oceanic with the European tongues, and analogies more or less real are indicated. These are often stretched beyond the limits warranted, perhaps with the laudable object of easing the student's path. The fact is the Oceanic family of languages is a distinct and separate creation, and must be followed on entirely different lines from those followed in Western speech. The inflections of our highly cultivated tongues add symmetry and elegance, but do not necessarily give flexibility. Even barbarous dialects can furnish in certain directions more varied locution for the conveyance of thought; for instance, in the Hawaiian language gender is denoted in two ways. There are five methods of distinguishing number. There are ten cases. There is almost endless variety in the arrangement of words, depending on the order of preference.

The Singular and Plural Distinctions.—The five ways of indicating number are:

1. By changing the article, as in most European languages, and saying *ka hale,* the house, or *na hale,* the houses.

2. By the use of the plural sign *mau,* which can be associated with any noun. Thus they have *he mau lio,* several horses; or,

3. One may employ a collective noun; as in

he poe haumana, a company of disciples;
keia pae moku, these islands;
he pu'u pohaku, a pile of stones;

Poe is applied to living things, *pae* to lands and islands, and *pu'u* to lifeless objects. These shades of meaning, invariably observed, impart a vividness to the language unknown to Western speech.

4. The plural may also be indicated by shifting the accent; as, *kanáka,* a man; *kánaka,* men. And, finally

5. The same idea may be expressed by using the work *ma,* which means literally a company.

Here then are five distinct ways of expressing an idea for which only two exist in our own language.

Tense and Case.—The distinctions of time are never so definite as in other languages, the chief attention being centered on the accidents of place. The word *ana* denotes continuance, and may be past, present, or future. Thus *e hana ana au* may mean, I *am* working, I *was* working, or I *will be* working, according to the connection.

Take the relations of case. There are ten. The six cases of Latin are well defined, and four of them—the genitive, accusative, vocative, and ablative—each have two shades of meaning, for which only one means of expression exist in English. Not only this, but one of the subgenitives, the *aui pili,* has two significations for which we have only one. This difference is so distinct in the Hawaiian's mind that the distinguishing words are seldom, if ever, used interchangeably. In designating the cases, recourse is necessarily had to Hawaiian terms, since no European tongue provides sufficient names. The extreme development of the case relation is seen by comparison. The English has 4; the Latin, 6; the Sanskrit, 8, and the Polynesian, 10.

The formation of words is one of the interesting phases of the language. As in all uncultivated tongues, intensity of expression is accomplished by repetition. This may be done by doubling a letter, a syllable, or even two syllables, as

a means to burn, *aa* to burn hotly;
naki means to bind, *nakiki* to bind tightly;
pulu means wet, *pulupulu* very wet.

A noted distinction before referred to in speaking of case is made between active and passive relations, as indicated by the prepositions *a* and *o*. If we refer to the house a man built, we use *a*; if he simply lives in it, we use *o*—*e. g.*:

ka hale a Keawe means the house that Keawe built;
ka hale o Keawe means the house that Keawe lives in.

a is employed in speaking of a man's wife; *o* in speaking of his maid servant—*e. g.*:

ka wahine a Keawe means Keawe's wife;
ka wahine o Keawe means Keawe's maid servant.

The literal translation is the *woman of Keawe*, but whether she bears the relation of wife or servant is indicated by the choice of prepositions. By the mere change of one sound in the sentence a husband may imply volumes of meaning.

A refers to an oven for you to cook with; *o* to an oven for you to be cooked in. In New Zealand they say—

he hangi mau; to cook with; but
he hangi mou; to be cooked in.

This introduction of a particle to completely change the meaning is common in some of the Romance languages. Take the example in Spanish:

Mi hermano quiere una criada; and—
Mi hermano quiere á una criada.

The first means that my brother wants a maid servant; the second, that he loves one.

Forms Similar to the French.—A striking similarity to the French exists where the noun is inserted between the two parts of the pronoun—*e. g.*:

ua moku nei = ce navire-ci = this ship;
ua mokú la = ce navire-là = that ship;

ua-nei being here a strong demonstrative.

Note also the resemblance between

keia and *kela*—meaning this and that—and *ceci* and *cela*.

The idea of *everything* would be expressed in Kanaka by that thing, this thing, *kela mea keia mea.*

In this phrase we see again the lack of generalizing power of the Polynesians.

The Hawaiian is one type of the agglutinated languages. The combination of the article with a proper name forms a new compound, in which, however, the original signification of the article is lost. The names of two of Hawaii's famous queens may be cited as examples.

Kapiolani means the heavenly prisoner; *Liliuokalani* is the lily of heaven.

IV.—SYNTAX.

Relative Pronouns.—When we come to compare the Polynesian languages with the Indo-European from the point of view of syntax, many interesting peculiarities are developed. The fact that all their mental action follows special lines involves a radical modification of our methods of expression. Some of our constructions apparently necessary and certainly logical cannot be employed.

No relative pronoun has ever been found in Hawaiian. This does not involve a lack of logical clearness. From their mode of thinking they find little use for relatives; but the meaning is just as unequivocal as though the sentence were constructed after a Latin model.

For example,

O ka'u poe ke iki ka poe nana ka laau,

means literally,

My children are those for them the timber;

or, freely translated:

My children are those *who will own* the timber.

Absence of Verbs.—In this last sentence we see several peculiarities. In the first place, *o* is used simply for euphony. It cannot be translated into English. Then the word *poe* has no equivalent. In the next place, there is no verb. Some of the strongest and clearest affirmations are made in Hawaiian without any kind of a verb; there is no verb in the language to express the idea of existence. The structure of the idiom does not require it. Neither is there any verb to express having or possessing, nor to express duty or obligation, nor to affirm any quality as belonging to any substance; but these ideas are necessary in the communication of thought. How, then, do the Hawaiians express them? In various ways:

I. By particles of affirmation, as: *he akamai kona,* a skill his—*i. e.*, he has skill. A construction similar to this is found in Hebrew and other Semitic languages.

II. By *he*, a simple article, as: *he pono ole,* a good not—*i. e.*, good does not exist therein. In other words, it is unrighteous.

III. Affirmation is sometimes expressed by the pronouns *ia*, *eia*, *keia*, etc., as:

O ia ka poe i hele mai (the *o* is emphatic).
(Those were) the people who came.

In fact, verbs play a very subordinate part in the language and are seldom employed, since their place is supplied, as occasion arises, by other parts of speech. Take the sentence that appears on the Hawaiian coins:

ua mau ke ea o ka aina i ka pono; meaning

(is continued) the life of the land by righteousness. The affirmation seems to be made in the first word, *ua*, although this is sometimes a supernumerary word, or at least an auxiliary one.

Position of Nouns.—A peculiarity about nouns is that they may stand in almost any part of the sentence except at the beginning. The whole method of affirmation is unique. It may be done by several parts of speech. Here is an example where a noun contains the idea:

I ka po ka lakou hana; meaning
In the night was their work.

In the following case there is no verb in the sentence, and the pronoun contains the declaration within itself:

(*Oia*) *ka mea i loaa i ka waiwai;* meaning
(That is) the thing to obtain wealth.

Some phrases are difficult to understand. This was once found in good Hawaiian:

O makou hoi, o na elemakule kane, a me na elemakule wahine;

which literally means:

We, also, the old men males and the old men females.

Just what is implied therein has baffled more than one Hawaiian scholar. The idea may be akin to that contained in the Spanish phrase *Voy á dar un abrazo á mis padres,* where the word *padres* is employed when both father and mother are meant, the meaning, of course, being that he is going to embrace both of them.

French and German Constructions.—In certain constructions two negatives are necessary just as they are in French. *Nele* means to lack, and *ole* means not; yet they are both employed, and, taken together, have the force of one negative only, as:

Nele na Kanaka o Honolulu i ke kumu ole.

This *ole* in our idiom would be superfluous but the Hawaiian requires it. The French *ne-pas* is precisely parallel, and the French equivalent of the Hawaiian phrase is:

Les gens de Honolulu n'ont pas d'instituteur.

The interjection of words between two parts of a verb as in the German is very common, as:

Na lawe malu ia ke dala.

The other form would be with *laweia* as one word; and the phrase translated into German, using a separable verb to show the correspondence, would be:

Man nahm das Geld heimlich weg.

Here is a case where the regular German separable verb construction is duplicated in Hawaiian.

Flexibility.—The Polynesians avoid inflection. But if their language is loose and cumbersome in this respect there are corresponding advantages. Indeed, from this very fact great flexibility becomes a necessity, and any sentence may be cast in a variety of ways, depending on the idea which is to take precedence or acquire emphasis. Take the phrase, 'I give this to you.' Here we have five words. The sentence may have as many different arrangements in Hawaiian, according to the shade of meaning sought. When it is desired to bring out the fact that an object is given and not loaned, the words *ke haawi* take precedence, as:

Ke haawi aku nei au i keia ia oe.

When prominence is given to the idea that it is I and not some one else who gives, the form is:

Owau ke haawi aku nei i keia ia oe

and so on through the five different arrangements, each laying stress on a different idea and all perfect models of pure Hawaiian syntax. It cannot be denied that this flexibility gives to the language a power and subtlety unknown in the inflected tongues.

We are all familiar with that inimitable scene in the *Bourgeois Gentilhomme*, of Molière, where a lover repeats in five different ways: "Fair Marquise, your beautiful eyes make me die of love." The actor succeeds in revealing an ardent passion, but his French is intolerable. An untutored Kanaka from the South seas would have been able to bring out in his native speech all these shades of meaning, impossible in the cultured language of France. But the French language, proud mistress that she is, will not tolerate these liberties of construction that the Polynesian tongues not only permit but even court. The higher the civilization, the more acute are the forms of thought. The more exacting the rules of syntax become, the more limited appears the capacity for flexibility.

It is a peculiar trait of the language that the same word may be used as a verb, noun, adjective, or adverb. As an example, let us take the common word *aloha*, and we have

As a verb: *ke aloha aku nei au i kuu hoalauna*—

I love my friend.

As a noun: *he aloha kona i kona hoalauna*—

he had love for his friend.

As an adjective: *he alii aloha no ia i kona hoalauna*—

he is indeed a loving chief to his friend.

As an adverb: *hana aloha ae la kela ia ia*—

that person treated him with friendship (love).

Even the pronoun I can be used as a verb. A native, relating his reply to the question as to who possessed a hat, said:

Owau aku la no hoi au owau,

which translated literally is:

I 'ied' to him, I

that is,

I said to him I had.

But then our language is sometimes given similar license. A schoolmaster once asked for an example of an interrogative pronoun used as a verb. No one was able to reply successfully except a mischievous urchin who had been thrashed for saying *what*, and his answer was, 'Give me that stick and I'll *what* you.'

Erasmus Darwin Preston.

(*To be continued.*)

SANDSTONE DISINTEGRATION THROUGH THE FORMATION OF INTERSTITIAL GYPSUM.

A block of Carboniferous sandstone from New Brunswick, carved in the form, and in imitation, of the Old Liberty Bell, was some years ago, owing to the crowded condition of the Exhibition Halls of the National Museum in Washington, removed to a point near the northwest entrance, outside of the building.

When placed in position the stone was fresh, and surface smooth throughout. Within the space of a couple of years there appeared on the northwest side a slight roughening of the surface and a whitish efflorescence which during the two ensuing years extended gradually two-thirds around the northern and southern sides, but was always most marked on the northwest. On examination the efflorescence was found to be due to the formation of small gypsum crystals, and the roughening of the surface to the falling away of the siliceous granules. The process has gone on until now more than an eighth of an inch in thickness of material has been removed from the point of surface first attacked, and the inscription in part obliterated, as shown in the accompanying illustration. It is to be noted that the zone of disintegration is limited wholly to that portion of the bell just above the middle, where the surfaces stand nearly vertical, while elsewhere the material is almost as fresh and unaltered as when first exposed.

An examination of the stone shows it to contain numerous small segregations of marcasite which are quite inconspicuous, or show up as small dark spots on the weathered surface. Chips of the fresh rock effervesce slightly in dilute acid, indicating the presence of calcite. The disintegration is doubtless due, therefore to the oxidation of the marcasite through the downward percolation of rain water, and the reaction of the sulphuric acid formed upon the calcium carbonate. The resultant calcium sulphate is then brought to near the surface by capillarity where it crystallizes, and, as growth takes place always from the base of the crystals the sand granules are gradually forced off in the manner so often exemplified in the lifting of soil through the formation of hoar frost. The writer has described (Proc. U. S. Nat. Mus., Vol. XVII., 1894, p. 80) the splitting of blocks of limestone through similar gypsum growths, as noted in the dry portions of Wyandotte and Mammoth Caves, but has never seen the phenomenon so well illustrated in sandstone as here. In as much as it offers an explanation for the disintegration of sandstone of this type where exposed in the walls of buildings, the case is worthy of mention.

The gypsum efflorescences, it should be

noted, have the plumose and curved forms occurring in the rosettes of the caverns mentioned.

GEORGE P. MERRILL.

THE NATURE OF THE SMILE AND LAUGH.

A DEFINITION of the smile and laugh is not needed by any one, for to every human being it is a self-evident birth-right, an axiomatic fact. Nor in general does this phenomenon (we shall consider in this essay the smile as only a lesser degree of the laugh) need description, and for the same reason. But the nature of the smile and laugh psychophysiologically does need explanation, why it is as it is and not otherwise. We shall try then here to look a little at the biological character of this incident of our common experience.

Herbert Spencer in his famous essay on 'The Physiology of Laughter' (1860), suggests as the occasions of the laugh, these: The ludicrous, joy, sardonic stimuli, hysterical states, mental distress, tickling, cold, and some acute pains. It seems, however, that pure or typical smiling and laughter comes from what is best termed joy, alone. It is only by inaccuracy of observation and a deficient consideration of certain facts that that smile-like expression of the face occasioned by 'sardonic stimuli,' mental distress, and acute pains is termed a smile, for while it is obvious, indeed, that the facial 'expression' of this tone of feeling is somewhat like that of unalloyed pleasantness, yet there are differences. These differences are chiefly in the mouth in the way of a greater uncovering of the upper teeth, with a different look about the eyes, the total appearance being harsher, in a way hard to particularize but very easy to feel. The so-called laughter of really painful states, at best only rarely observed, seems to depend on the well-established affective principle that the extremes of contraries tend to produce like effects, probably through the occurrence of wide radiation in the cortex, as would be expected when the stimulus is on the verge of abnormality of strength. Again, it must be remembered that so perfect and sensitive is the neuromuscular mechanism in question that even in an experience which is chiefly unpleasant or painful, even a momentary idea of any sort, or a brief cessation of the pain (in itself a pleasantness), would serve as the occasion of a true smile and so complicate the expression, giving it more the look of a properly occasioned smile. Tickling, on the other hand, is essentially pleasant if not too long continued; and it is characteristic of hysteria in a marked degree that it simulates arbitrarily every known emotion to perfection, or rather is in itself a versatile emotional state. It seems proper then to consider the laugh and smile as concomitant properly only to pleasantness or to pleasure, whether this affective tone be derived from purely conceptual relations, as in humor, or from stimulation of whatever bodily organs are in their action concomitant to pleasure.

One may observe even within the first week of the post-natal life of the infant that the eyes and especially the mouth display at times an incipient smile, the purely reflex or mechanical accompaniment of a true sensational pleasantness, arising usually from the normal functioning of the digestive process. A very few weeks later (two, as I have observed in one infant), the consciousness has become so far familiar, so to say, with its organism, as to bring out nearly if not quite in all its adult details the action of the inborn intricate mechanism of nerve and muscle. The 'hearty laugh' does not seem to occur until a somewhat later period, aloud and briefly perhaps by the end of the eighth week, but as a general bodily process not before two or three years of life have passed; this is not, probably, because of any incompleteness in the apparatus of laughing, but because humor, which is the commonest occasion of this extreme manifestation, is not appreciated earlier. It seems probable that the shock produced by the sudden understanding of the 'point' of a joke has much to do with the intensity of the reaction in this case.

The practical perfection of the smile and laugh (as of the expression of grief and pain) at this very early period of life is a fact in itself worthy of note, and serves to emphasize both the universality of laughter in man and its deep-founding in the organism. When a few weeks old, or when even a few months old commonly, the average infant has not voluntary control enough over even its most mobile members, the finger and thumb, as to extend the latter into its mouth, even when the child searches his hand with his mouth with great eagerness for some much desired projection, and that even when it has been so extended for him repeatedly. The contrast of such helplessness with the innate perfection of the smile, involving the simultaneous action of a dozen or more muscles on each side of the face, is a striking illustration of innate reflex function, and little less remarkable than the mechanical actions of sucking and digestion themselves. It seems indeed proper to suppose that the nervous mechanism for the 'control' of so complex a set of movements should be related to the deepest and most basal opposition in which the muscles are concerned, namely the functions of extension and of flexion, of increasing and of decreasing respectively the general superficies of the body. Imitation has clearly little or nothing to do with the original process of the smile, for many weeks after the child can smile to perfection, he is totally unable to imitate even the bending of a finger although the simple act be performed a hundred times before his eyes. It must surely be judged that the smile is wholly instinctive and in a sense reflex, a psychophysical characteristic of at least the human young by the inherited law and structure of its being.

The biologic purpose and value of the smile and laugh are not far to seek, not much further indeed than are those of the expression of grief and pain as the appeals of the crying needs of the child to his mother: both of these are obviously biologically protective and preservative. A glance at the usefulness of the smile will show what in part has made it so invariably an aspect of the psychophysical life of man, and, doubtless by imitation, perhaps of some of the highest brutes. In the infant the smile very early becomes the index of the parental attitude toward him, and hence, because of its great biologic interest for his personality, he is apt instinctively to become at a surprisingly early period fairly learned in the physiognomy of the smiling, as of the frowning, face. Again, when the time has come in the course of nature that the young man acquires a highly specialized interest in one of the opposite sex, the smile becomes to a quite characteristic degree the object both of admiration and of further study. Later on, in business life, the smile, as exponent of the emotional attitude of those with whom the struggle for existence puts the man into some sort or other of competition, becomes even commercially important, and when an individual has profited so well by his long subconscious study of smile physiognomy that he can in general distinguish the natural or true smile from that of him who can smile and smile and be a villain still, his education in this direction may be called complete. It is because the smile is normally the indication of a pleased friendliness that it plays so important a part in the serious affairs of social intercourse, as useful as such to the schemer and the rogue as to the one enjoying properly the pleasurable society of his friends.

In his classic treatise on emotional expression Darwin gives the results of his numerous inquiries of persons in all parts of the earth as to laughter among savage races, and these were invariably to the effect that the phenomena is identical among them all: the seemingly wretched dweller in Terra del Fuego or the pigmy in the dark forest of the heart of Africa smiles precisely as does the newly made peer of Britain when he is alone, and for a precisely similar reason—because he is at that moment unusually happy. The cannibal may laugh at the contortions of his victim roasting in the fire before him, and the pampered infant in his nurse's arms may be wreathed in smiles at the prospect of another sugared 'cookie,' but the process in the two cases is not different and the physiologic cause is the same—pleasure, or the prospect of pleasure in itself pleasant. Dogs and monkeys are not infrequently seen to smile, and there are many who consider certain joyous manifestations in other animals as properly laughter. The nearly continuous state of smiling or laughter often seen in the case of imbeciles may obviously be taken as the reflex organic co-ordinate of that constant tone of pleasantness which these persons doubtless usually experience. The limitation of intelligence in these subjects makes it impossible for them to realize the serious burdens of life, while the somatic process, to an awareness of which their consciousness is often reduced, certainly gives as its psychic tone a complex sense of pleasantness or even of pleasure. It is on this account that in very young children, savages, and imbeciles the smile is to be observed at its purest, physiologically speaking.

Aside from innumerable references and descriptions, throughout general literature, of the phenomena we are discussing, the technical treatises on their physiology have been relatively numerous in all ages, although many of the books which pretend to explain laughter are really treatises on wit or on humor or on both, and contain little or nothing physiological, while the riddle why humor causes laughter and what the former is withal, is still as far as ever, apparently, from its interesting solution. It is sufficient for us that we ignore wit and humor, and begin with the *pleasantness* which these, together with innumerable other causes, produce in the soul. With this we may start with entire confidence, for, save perhaps in rare abnormal cases, the smile and laugh are everywhere the natural 'expression,' or, better, correlates, of pleasantness or joy in the individual. What, then, are the bodily accompaniments of general pleasantness in the human animal? The more conspicuous of the reactions may be suggested as follows, which later on we shall endeavor to explain and to account for.

There occur in laughter and more or less in smiling, clonic spasms of the diaphragm in number ordinarily about eighteen perhaps, and contraction of most of the muscles of the face. The upper side of the mouth and its corners are drawn upward. The upper eyelid is elevated, as are also, to some extent, the brows, the skin over the glabella, and the upper lip, while the skin at the outer canthi of the eyes is characteristically puckered. The nostrils are moderately dilated and drawn upward, the tongue slightly extended, and the cheeks distended and drawn somewhat upward; in persons with the pinnal muscles largely developed, the pinnae tend to incline forwards. The lower jaw vibrates or is somewhat withdrawn (doubtless to afford all possible air to the distending lungs), and the head, in extreme laughter, is thrown backward; the trunk is straightened even to the beginning of bending backward, until (and this usually happens soon), fatigue-pain in the diaphragm and accessory abdominal muscles causes a marked proper flexion of the trunk for its relief. The whole arterial vascular system is dilated, with consequent blushing from the effect on the dermal capillaries of the face and neck, and at times of the scalp and hands. From this same cause in the main the eyes often slightly bulge forwards and the lachrymal gland becomes active, ordinarily to a degree only to cause a 'brightening' of the eyes, but often to such an extent that the tears overflow entirely their proper channels. The whole glandular system of the body seems to be likewise regularly stimulated (pleasantness being sthenic to the organism), causing the secretions, gastric, salivary, sudoral, mammary, genital, to be augmented, with a consequent rise of body-temperature and a general expansion of cellular activity. Volubility is almost regularly increased, and is indeed one of the most sensitive and constant of the psychophysical signs of moderate delight, although often quite inhibited in the excessive degrees of joy.

In the true scientific spirit, without thought doubtless of desecrating the fame of 'the human face divine,' the most beautiful of things, Angelo Mosso calls the face 'a muscular funnel at the end of the alimentary canal,' and in an interesting way he accounts for the complexity of its muscular portions by the obvious needs of seizing, masticating, seeing, etc. Moreover he points out four reasons why the facial muscles are so mobile, and these are as follows: first, because of their small size; secondly, because of their continual usage; thirdly, because of the close connection of their motor nerve, the Seventh or Facial, with the deep-lying cerebral centers; and lastly, because, as he thinks, there is no mechanical opposition between them. Accepting the first three of these as undoubtedly valid, with the last it seems from considerations soon to be suggested necessary to disagree, because it is probably erroneous. It is going back even to Aristotle to maintain that function is more fundamental than structure, and a reminder of the affective opposition which obtains in the face in the conditions on the one hand of joy and on the other of grief is all that is required. In the one case the features may be considered as drawn upward and in the other as drawn down. But in structure as well as in affective functioning, the opposition between these small and numerous bundles of muscular fibres may be clearly demonstrated if only the research be conducted at the proper period of development, the fœtal, and if only the neural paths and centers by which these muscles are directed be considered as part of their mechanism, as is philosophically necessary. From no point of view other than this is there structural opposition between any of the muscles, for histologically all, throughout the body, are similar (save as regard differences which are here beside the point). It is in fine a portion of our present thesis that the muscles of the face are extensor or flexor as are the other muscles, for the most part, of the body—an opposition at once functional and morphologic.

Now continuing to confine ourselves mainly to the facial manifestations of the bodily side of laughter (for it is here that the greatest general interest lies), let us see what are the broad general principles or biologic tendencies which underlie and make the smile and laugh what in fact it is.

In a monograph named 'The Emotion of Joy' (Macmillans, April, 1899), the writer summarized the results from nearly three years of research in the psychological laboratories of Harvard and Columbia Universities into the bodily processes which respectively correspond to pleasant and to unpleasant periods of consciousness. Some thousands of experiments made during that time on normal subjects (mostly students and professors of philosophy), demonstrated among other things that even in animals so far from biological näiveté as these, there exists a psychophysical principle which can be concisely stated as follows: *In general, states of pleasant consciousness are correlated in the body by contraction of muscles classed as extensor, and, conversely, states of unpleasantness with contraction of flexor muscles.* This is an ancient and more or less popular hypothesis, but usually in a form where bodily expansion and contraction are suggested rather than muscular extension and flexion respectively, a tendency indeed which is to be observed in very many animals from the amœba, the type, upward in morphologic complexity. This expansion-flexion tendency, so to call it for convenience, being then an inherent opposition in the neuro-muscular structure of animal organism in general, its relations to the hitherto mysterious phenomena of the smile are of a certain general interest. Now it appears, in short, that *the smile and laugh are in fact fully explained by this general biologic principle*, as will become clear from the following considerations:

Even as the affective principles are manifested as early as animal life itself, so must one search very early in the morphologic changes of the individual, very likely indeed in the early stages of the embryo, for the forms which normally determine adult affective structure and function. Function is properly more primary than form, and one generation determines by its habits to some extent invariably the structure of the next; we should look, then, to the early embryo for the direct correlation of the functions which are to obtain in the adult life. At any rate, in the fœtus we find conditions, more plainly marked than in later states, which make adult functional relations clear. Although the 'primitive streak' is at first necessarily straight, folding begins very early, and at the end of the first month, in the human fœtus, the embryo is bent upon itself to a very marked degree. The curve which forms in the region afterwards the lower cervical is for our purpose the most significant, although the growth forward of the anterior lobes helps in the case of man to make this antero-posterior bending more marked and physiologically more significant. This curvature remains quite patent in the adult in all the canals which extend from before backwards in the head: First, in the ventricles of the brain from the third to the 'sixth' down the spinal cord. Second, from the nostrils upward and backward and then downward into the trachea. Third, from the mouth similarly upward and backward and downward into the œsophagus. All these in a proper philosophic sense outline even in the adult forms the curve which, at the period of individual development when the functions of the muscular system were being firmly established in the formative plan of the organism, is even more plainly apparent. In the strongly prognathous type of structure these conditions are all emphasized, as they are in animals with long probosces which these muscles in part serve to extend. It is at this very early formative period that the neuro-muscular system is beginning to take on its basal opposition of flexion and extension, the large muscle of the scalp, the Occipito frontalis, being the strikingly complete type of this far-reaching functional division, for the frontal half draws directly backward in a way to tend to extend the face and the head.

On this same dual principle do all the facial muscles act, as may be seen from a brief technical rehearsal of the most important of them and their functions. The Risorius, the 'laughing muscle,' draws upward and backward the corners of the mouth; the Zygomatici have a similar action on the lower jaw; the Levator labii superioris, as its name perhaps sufficiently implies, lifts the upper lip, as does the Levator labii superioris et alæque nasi, and in addition the outer and lower walls of the nostrils; the Levator menti lifts the soft parts of the chin; the upper portion of the Orbicularis palpebrarum raises the skin about the eyes, and the Pyramidalis that over the root of the nose; the Dilatores nasi lift and expand the lower portions of the nose; the Rectus oculi superior rotates upward the ball of the eye; and the Corrugator supercillii raises the inner ends of the eyebrows until the latter are straight. Thus all these, physiologically speaking, tend when they contract to straighten the curve which, morphologically, extends from the upper portion of the vertebral column upwards, forwards, and then somewhat downwards to the chin, and hence by this fact they tend to complete what is biologically the extension of the body.

It is thus seen that those muscles of the face which take part in or actually produce the facial portion of the 'expression' of joyful emotion, those in other words which by their movement constitute the smile and laugh, are extensor in the same sense as are those of the hand, neck, forearm, leg, and trunk, whose contraction has been previously demonstrated (see research referred to above) to be correlate with the pleasantness of the individual's experience at the time, although it is evident that the general form of the face and its complex functions make this myologic division of function less obvious than in case of the muscles of the rest of the body. The smile is then nothing exceptional, and is no more mysterious than is this general duality of action which obtains in every portion, apparently, of the muscular and neural mechanism.

Study of unpleasant affective states negatively corroborates, as we have already suggested, this explanation of the nature of the smile and facial laugh by exhibiting quite the opposite muscular reactions, as the term 'long face' so well implies in common speech. In disagreeable periods of experience the head, furthermore, is apt to be bowed, the eyes downcast, the eyelids lowered, and the corners of the mouth and the skin of the forehead drawn down. This opposition was the basis doubtless of the 'principle of antithesis' announced by Darwin the second of his principles of expression, and which has met with so great resistance from many modern physiognomists; it now appears in a new and a much stronger light as indeed a deep-lying tendency in living organisms.

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*REPORT ON THE WORK OF THE MORRILL GEOLOGICAL EXPEDITIONS OF THE UNIVERSITY OF NEBRASKA.**

THROUGH the generosity of the Hon. Charles H. Morrill, of Lincoln, the expeditions sent out from the University of Nebraska, known as the Morrill Geological Expeditions, have become a permanent organization of the University. Therefore, it is but a fitting mark of respect that reports of these expeditions be given to the Nebraska Academy of Science from time to time in order that they may become matters of record. Introductory to this work, a private geological excursion was undertaken in June of 1891, by Mr. Erwin Hinckley Barbour in the interest of the University of Nebraska. At this time the Dæmonelix beds of our State were discovered and explored, and the Bad Lands of Nebraska and regions in South Dakota were visited, the result being that a very considerable collection was made and several new genera and species found. In May of 1892 a second trip (likewise at private expense) was made to the Sioux county Bad Lands and to the Dæmonelix beds. Again a large amount of material was secured and added to the collections of the State Museum. At this

*Paper read before the Nebraska Academy of Science.

juncture the Hon. Charles H. Morrill, of Lincoln, came forward with liberal contributions for the prosecution and continuance of the work. Then followed during June, July and August of the same year the first of what has become the annual Morrill Geological Expeditions.

A well equipped party of six (exclusive of guide) namely: T. H. Marsland, F. C. Kenyon, A. C. Morrill, H. H. Everett, J. H. Haines and Erwin H. Barbour in charge, visited the Bad Lands of the State, and especially the Dæmonelix beds, continuing thence into South Dakota and to the Dinosaur beds of Wyoming.

In 1893 a similar sum given by Mr. Morrill made possible the second annual Morrill Geological Expedition which visited and collected in the Rhinoceros beds of Kansas, the Hat Creek Bad Lands and the fossil Corkscrew beds in the Loup Fork Tertiary of Sioux county. The party consisted of T. H. Marsland, H. H. Everett, with Erwin H. Barbour in charge. Later the director of the expedition extended the work of collecting to the Middle and New England States.

The third annual Morrill Geological Expedition, 1894, consisting of U. G. Cornell, H. H. Everett, A. C. Morrill, E. L. Morrill, J. P. Rowe, Samuel McCormick, guide, Erwin H. Barbour, as director, drove from Hot Springs to the Big Bad Lands of South Dakota where some six or eight weeks were spent, thence to the Black Hills and beyond into Wyoming and Montana. The result of the expedition being that an unusually large amount of material of great variety including fossils, minerals, rocks, etc., was secured.

In 1895 the fourth annual Morrill Geological Expedition consisting of U. G. Cornell, H. H. Everett, F. G. Hall, G. H. Hall, E. F. King, J. P. Rowe, G. R. Wieland, T. H. Marsland, Francis Roush, guide, Erwin H. Barbour in charge, continued work from the Dæmonelix beds and the Little Bad Lands of Nebraska to the Big Bad Lands of South Dakota thence to the Black Hills and beyond. This was the largest and best equipped party sent out as yet.

In 1896 the fifth annual Morrill Geological Expedition extended its work to eastern fields, spending some time in the Carboniferous of Nebraska, a week in the Devonian of New York, and a couple of weeks in the Silurian of Ohio and Indiana.

In the summer of 1897 the sixth annual Morrill Geological Expedition consisting of B. G. Almy, U. G. Cornell, O. A. Reitz, Francis Roush, guide, Carrie A. Barbour, E. H. Barbour in charge, again visited and collected in the Big Bad Lands of South Dakota, the Black Hills region, the Little Bad Lands, the Dæmonelix bed of Nebraska and beyond into Wyoming.

In 1898, the seventh expedition was influenced by the Trans-Mississippi Exposition in Omaha, and the museum force and assistants in the geological department became interested in the preparation of exhibits illustrating our natural resources. The quarries of the State, more particularly those of southeastern Nebraska, were visited and important economic sets of building stones, clays, soils, etc., were added to the Morrill collections.

The eighth expedition, 1899, was divided into five distinct parties, two of which were provided with teams and camp accoutrements, the other parties going by rail from place to place. A party of two followed the Dakota cretaceous from Oklahoma to South Dakota. Another drove through the quarry regions in southeastern Nebraska. A third party, a graduate student in the department of geology, spent the summer collecting Bryozoa in the Carboniferous.

The writer with assistants, spent some weeks collecting invertebrate fossils in the carboniferous exposures, while the director, with an assistant, visited fields in Wyoming, Montana, Dakota, and Nebraska. Over two hundred boxes of excellent material were added to the collections of the State Museum.

A geological expedition for 1900 is already assured by a recent gift, to that end, made by Mr. Morrill to the Board of Regents of the University of Nebraska.

In each instance the Burlington & Missouri River Railroad furnished free transportation for the party and 'outfit' as well as for all material collected. So with free transportation, and the gratuitous service of students of the University of Nebraska and with all expenses defrayed by the Hon. Charles H. Morrill, a maximum amount of material at a minimum cost was massed together. Sets of duplicate specimens have since been donated to 40 accredited high schools, academies, and colleges in the State, and exchanges have been made with the following universities: Ohio, Utah, Kansas, Minnesota, Columbia, Case School of Applied Science and to the Field Columbian Museum, and the National Museum. These collections seem to have unusual exchange value, the demand for them even exceeding the supply. The usefulness then of Mr. Morrill's work has extended beyond the limits of the State, and while contributing to the cabinets of others, his own collections have been so enriched as to fill most of the cases on the main floor of the State Museum and some of the cases on the second floor.

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SCIENTIFIC BOOKS.

The Cyclopedia of American Horticulture. By L. H. BAILEY and WILHELM MILLER. Comprising suggestions for cultivation of horticultural plants, descriptions of the species of fruits, vegetables, flowers and ornamental plants sold in the United States and Canada, together with geographical and biographical sketches. In four volumes. Illustrated with over two thousand original engravings. New York, The Macmillan Company. Vol. I., A. to D., pp. xxii + 509, figs. 743.

In these days of the rapid multiplication of books no small responsibility attaches to their reviewers. Indeed the reviewer may assume a greater responsibility than either the author or publisher, for to him prospective purchasers and readers turn in the confident expectation that he will so advise them that they shall waste neither their money nor time. In the world of letters, to be sure, it may be an actual merit in a book that a hot summer's day, a monotonous railroad journey, or a number of restless hours at bedtime can be sunken in its perusal. But outside the pastime series, the information conveyed is expected to be accurate and proportionate in quantity and value to the time consumed in getting at it. And it is precisely for advice on this point that the public turn to the columns given over to the reviewer; for the author, as a rule, modestly refrains from sounding the praises of his ware, and the publisher quite as commonly advertises a book for what it ought to be as for what it really is.

One of the first questions that the reviewer faces nowadays, he most frequently leaves unanswered on paper, however he may answer it in his own mind, namely, why the book has ever seen the light. For himself, since the thoughtful publisher has sent him a copy with the compliments of the house and the card of the author, he does not need to decide whether it is worth the cost of purchase, and so he passes by the line of least resistance to the independent discussion of its merits and demerits.

This question of the need for its publication is more readily answered for the 'Cyclopedia of American Horticulture,' than for most books, since it is easier to answer it on the merits of a book alone when the book belongs to a class that does not comprise many titles, than when hundreds of books of about the same scope have been brought out. There are few comprehensive books on Horticulture, and none on American Horticulture which cover the ground mapped out for the new Cyclopedia. A generation or two ago the books of Loudon and Lindley told, more or less in a nutshell, what was known of economic plants, and the exquisitively conceived little Treasury of Botany of Lindley and Moore has made more intelligent gardeners than perhaps any other one book. Still, when Mr. Nicholson of Kew undertook the compilation of a Dictionary of Gardening nearly a quarter of a century ago, none of these works were sufficiently recent or full to prevent his book from appealing to the horticultural public, for whom it has done very much. But a quarter of a century is a long time as viewed by the gardener whose business shifts from carnations to roses, from roses to chrysanthemums, and from chrysanthemums to cactus-dahlias, and whose need to meet closer competition is often tided over by the introduction of simpler or cheaper methods applied to vast quantities of one thing that must be marketed by thousands before the infinitesimal profits have counted up to the point where they require banking, though beyond this point they may aggregate a very handsome revenue each year if only the business done is large enough; and this has led to the publication, within recent years, of excellent floricultural books, by Henderson, Scott, Hunt, and a host of other men whose business success stands as an endorsement of their teachings.

But these books are limited in their object, and although Nicholson's Dictionary has been able to grow somewhat in the course of a long-drawn-out rendition into other languages than the English, it does not even then give all the information needed to-day about decorative plants; and the newer methods by which success has so largely been achieved in this country, are not to be learned from it. Professor Bailey's book, therefore, aiming at the presentation of the plants and methods of American horticulture to-day, meets a real need in the library and the potting-shed, and it would be just as useful if the year of its appearance did not end in two ciphers, though its historic reference value may possibly be enhanced by the catching circumstance that it presents these facts as they exist at the end of the nineteenth century.

If the entire authorship of such a work had fallen upon one man, Professor Bailey possesses a sufficiently broad knowledge of botany and horticulture to have written it well, and if, as he plans, it shall all appear within a year from the time when we are privileged to open the first volume, he will have shown an administrative faculty, that, in botanical book-making in this country, stands alone, except for Dr. Britton's prompt publication of the illustrated flora of our eastern states, which several times found mention in these columns a few years ago. Of course he would not have been able to effect this prompt publication unaided, and no small credit for the result attaches to his energetic collaborator, Mr. Miller; and well as he might have written it, he would not have done it alone so authoritatively as he has done it with the aid of corps of specialists, comprising the best botanists and the most expert gardeners of the country, whose names occupy several pages of double column matter at the beginning of the book, and behind whom stand still other helpers whose names at their own request do not appear, though his readers get the benefit of their knowledge.

I suppose that it is impossible for the most rational of men to open a book without finding in it more than they expected, or to lay it down without a sigh of regret at the absence of something that they wanted to find. Professor Bailey's book is not different from other books in these respects. Open it where you will, and you find a tasty cut or a catching paragraph which holds your attention and gives you something you had not intended to look for. And yet if you are an every-day gardener and want to distinguish the different varieties of chrysanthemum or carnation, of apricot or cauliflower, you may fail to find there the means of doing so.

Where races differing from one another more than many species do in nature are made to order, almost to drawing and specification, on a few years' notice, it is very difficult either to find space for their description in a book of any reasonable size or phraseology that can supply to the ordinary reader the distinctions that are patent to the eye of the specialist. The editors have therefore, without doubt, done wisely in a very conservative treatment of these necessarily transient forms, which pass from view as a rule almost as suddenly as they appeared with gorgeous lithographic depiction in the catalogues of dealers. But the editors have done something with them, and they have handled the more lasting forms with a rather surprising fulness of treatment.

Nomenclature, which is a source of some concern and more confusion to botanists, has been conformed, more or less consistently, to the more conservative horticultural and botanical views. It could not give satisfaction in any case, and it has at least the merit of simplicity as it has been handled.

In a word, whatever one would most reasonably look for in a Cyclopedia of American Horticulture, is to be found in Professor Bailey's book. While good things may have been omitted from it, the present reviewer has not found bad things that have been introduced into it; and it is worthy of a place where not only gardeners and botanists, but school-children may see it daily.

WM. TRELEASE.

La nature tropicale. By J. CONSTANTIN. Paris, Felix Alcan, Ed. Pp. 315, figs. 166. 1899.

The first chapter of this book is chiefly comprised of selections from the expressions of various naturalists on their first encounter with the forests and jungles of the tropics, and the second analyzes the principle factors in the equatorial climate. Succeeding chapters are devoted to trees and their architecture, foliage, periodicity, flowers and fruits, the tropical forest in previous geological epochs, climbers of all kinds, parasites and parasitic action of flowers, saprophytes and epiphytes, co-operation of ants, influence of the sea, the mangrove, the flora of islands and the final chapter is a singular mixture of fanciful conceptions relative to the earlier history of the earth and the cosmos, with enough of an admixture of mythology and tradition to endear it to readers of tender years. The general style of the book is not unpleasant, and although most of it might have been written a decade since, yet some recent results have crept into the discussions, especially in regard to the more sensational discoveries in botany. A table of contents placed at the end of the book does not redeem the lack of a suitable index.

D. T. MACDOUGAL.

Fossil Flora of the Lower Coal Measures of Missouri. By DAVID WHITE. Monographs of the United States Geological Survey, Vol. XXXVII. Washington. 1899. 4to, cloth. Pp. 467; pls. 73.

This work is based upon material collected by Dr. J. H. Britts and by geologists of the Missouri and United States Geological Surveys, in Henry county, Missouri.

It may be regarded from either the point of view of the geologist or from that of the paleontologist, but it is essentially a contribution to paleo-botany in which the facts are utilized for purposes of correlation and comparison between the coals of Missouri and those of the Eastern United States and Europe.

The species enumerated are 124. Of these 10 are gymnosperms, 1 (*Palaeoxyris*) is classed provisionally under 'Animalia?' and the remainder are cryptogams, most of them previously described. The discussion and table of synonomy under each genus and species is exceedingly full and a number of changes in nomenclature are made in order to bring it into harmony with modern ideas on the subject. The systematic arrangement is in accordance with the botanical affinities and sequence of the species and families.

Several innovations may be noted in the matter of illustrations. The figures are mainly reproductions of photographs of the rock containing the species, accompanied by drawings of portions of the species in which details of outline, nervation or fructification, etc., are shown. This method gives a good general idea of the actual appearance of each specimen as a whole together with the particular features which require emphasis, but such plates are not equal, for purposes of exact study, to reproductions from carefully made drawings, as may be seen by a comparison between Plates XL. and XLI. Another innovation which has produced excellent results is in the line of enlarged photographic reproduction, an example of which may be seen on Plate LI.

In the final discussion of the flora there are tables of distribution, for purposes of comparison with other coal floras and the conclusion is reached that the stratigraphic position of the Henry county coals is subsequent to the lower coals of the Lower Coal Measures of the East, including the Morris or Mazon Creek coal of Illinois and the Brookville or Clarion coal of Ohio and Pennsylvania, but previous to the Darlington or Upper Kittatinning coals of the latter States. A comparison with the British coal flora indicates that the flora of the Henry county deposits is represented to a greater extent in the Upper and Middle Coal Measures of Great Britain than in the Lower; probably in age about that of the basal portion of the Upper Coal Measures of that country. Interesting comparisons are also made with the coal floras of Continental Europe. It is to be regretted that in this, as in all similar large works, many of the finer points in comparative biology are necessarily omitted or else are more or less hidden in the mass of the systematic arrangement. There is no doubt that several of the species are capable of even more critical treatment that is given to them, but every one must recognize that the author has performed an immense amount of investigation and has produced a work of permanent scientific and economic value.

ARTHUR HOLLICK.

Analyse microchimique et spectroscopique. By M. -E. POZZI-ESCOT. (Encyclopédie scientifique des aide-mémoire.) Paris, Gauthier-Villars, Masson et Cie. P. 192, figs. 40.

Chemists the world over, have awakened, within the last few years, to the fact that the microscope is a most valuable accessory to every laboratory of chemical analysis. This increasing interest has been remarkably slow considering the almost inestimable value of this instrument as an aid in chemical research. The failure, in the past, to make use of the microscope has been, doubtless, due to two causes: first, the fact that instruction in the use and manipulation of this instrument has not been, heretofore, included in the courses of study offered to students fitting themselves for chemists in the various educational institutions; second, there has been a lack of suitable text-books, manuals, etc. The latter cause has been eliminated by the recent publication of several works. Of these the latest is the little compend of M. Pozzi-Escot published under the title given above. The appearance of this outline of the methods of microchemical analysis can be taken as indicating an increasing appreciation of the great value of the microscope to chemists, and friends of the system will, therefore, gladly welcome the little book although it is almost entirely a compilation of methods and reactions already published. It is but fair to the author, to state, however, that the material has been well chosen and due credit has been given to the originators of the different tests and processes.

The author gives a concise review of the rise and development of microchemical analysis. Then follows a description of the requisite apparatus and reagents, the tests for the different elements, and finally a more detailed discussion of the methods to be employed in the systematic analysis of unknown substances.

It is greatly to be regretted that the elements have been arranged in alphabetical order and that no details are given as to the way of applying the tests, nor (save in a few cases) of the causes which may lead to their failure. Any attempt to make microchemical analysis a purely mechanical matter is certain to give the beginner no end of difficulty and, moreover, is apt to mislead him into the idea that a knowledge of chemistry is not an essential in the interpretation of the tests obtained.

Reactions for sixty-three elements are given, most of which are satisfactory and are illustrated by original or copied drawings of the crystals to be obtained.

Chapters III. to V., dealing with the methods to be employed in a systematic analysis, are much better than those preceding. The necessary manipulations being described in detail and cautions as to sources of error are also given. This portion of the work can be consulted with profit by all those interested in the neat and elegant methods of microchemical analysis and renders it worthy of a place in the analytical laboratory.

That part of the book devoted to spectroscopic analysis comprises only nineteen pages. It would have been better had the author omitted this section entirely and devoted the extra space to a more thorough discussion of reactions and to an index.

E. M. CHAMOT.

CORNELL UNIVERSITY.

Qualitative Analysis for Secondary Schools. By CYRUS W. IRISH, A.B. (Harvard), Head master of the Lowell High School, Lowell, Mass. American Book Company.

The preface of this book states that in secondary schools "the first half of a one year's course in chemistry should be devoted to a general introduction to the theory of the science and to a close study of the most common non-metallic radicals. The second half-year should deal with basic radicals and should be combined with the study of Qualitative Analysis." It is to supply a manual for the latter part of such a course that this little book has been written.

The laboratory work begins with a series of experiments, illustrating the classification of the bases into analytical groups. Metals are selected as typical of the various groups, and the action of each group reagent, in turn, upon a solution of a salt of each of these metals is studied. The metals of a group are then taken up in order, preliminary experiments being followed by a few well-chosen questions on the experiments and on the occurrence, preparation, uses, etc., of the element under consideration and its compounds.

The directions for the analysis of a group are followed by a table outlining, by the use of formulæ, the chemical changes which take place in the course of analysis. In the reviewer's opinion the preparation of such a table by the student himself, from the data secured in the preliminary experiments, is much better and is one of the most profitable exercises which can be given him. In this manual the table is followed by 'notes and suggestions' which are altogether too brief. Space might have been gained for the expansion of this part of the book, by the omission of lithium and all but the more common inorganic acids.

As is usual in manuals of qualitative analysis, the section devoted to the acids is unsatisfactory. In the test for an acid, the behavior of other acids under the prevailing conditions is disregarded. The most convenient method of preparing a solution for the detection of the acids, viz, treatment of the substance with sodium carbonate, is not directly mentioned, while there is given in full the preliminary examination of the solid substance, the results of which, in the case of mixed substances, can only be interpreted by the more advanced student.

The methods used for the separation of the bases are for the most part well-chosen. Most teachers would prefer, however, to adopt for high-school students methods for the separation of nickel from cobalt and of copper from cadmium, which do not involve the use of potassium cyanide. The directions for the precipitation of the copper group (p. 36) are faulty in that they favor the incomplete transformation of mercuric compounds into the black sulphide, which will frequently result in a precipitation of mercuric sulphide in the final test for cadmium. On page 42 occurs this misleading paragraph, "Boil stannous chloride with concentrated nitric acid. This converts the stannous chloride into stannic chloride."

The introductory chapter lacks the lucidity of style which should characterize an elementary text-book. The statements, "the specific name of a salt is the name of the basic radical changed to an adjective" (p. 8), and "substances that are in solution can be separated by addition of such a reagent as will form a new substance that is insoluble in the fluid" (p. 12) will surely appeal to the high-school pupil as little as does the following prescription to the chemist, "for Alkali Burns, apply acetic acid diluted with water so that to the taste it is about one-fourth as sour as vinegar. This solution may be safely applied to the eye" (p. 15).

Notwithstanding these faults, the book might produce good results in the hands of an experienced teacher of chemistry. Whether a year's course in chemistry in a secondary school may not be profitably spent in a thorough and extended study of what is usually called general chemistry to the exclusion of anything more than the merest elements of qualitative analysis, is another question.

THEODORE WHITTELSEY.
CORNELL UNIVERSITY.

The Psychology of Religion. An Empirical Study of the Growth of Religious Consciousness. By EDWIN DILLER STARBUCK, Ph.D., Assistant Professor of Education at Leland Stanford Junior University. With a Preface by WILLIAM JAMES. London, Walter Scott. 1899. Pp. xx + 423.

Within the last decade a number of articles have appeared that center about the religious phenomena of adolescence and point the way toward a scientific religious pedagogy. Two of these were by Professor Starbuck (*Am. J. Psy.*, VIII. and IX.), and out of them, by the help of improved methods and of largely increased data, the present volume has grown. Part I. treats of conversion, Part II. of religious growth not involving conversion, and Part III. of the essential unity of the two lines of growth. It is shown that conversion is essentially an adolescent phenomenon, that parallel experiences occur where strong upheavals are absent, and that these experiences in their totality are intimately related to the bodily and mental phenomena connected with puberty. The general outcome is a clear exhibition of the various ways in which the religion of childhood gives way to that of maturity.

The study is purely empirical. In fact, its freedom from all apparent consciousness of dogma is rather remarkable. The data consist of statements of personal experience from more than 400 persons who have replied to question list circulars. The fact that nearly all the respondents are American Protestants and that the research concerns the adolescent period almost exclusively, suggests a question whether the title is not somewhat too broad for the contents of the book. It is only fair to say, however, that the data have been so related to physical and mental laws as to display general rather than merely special tendencies. The manipulation of the returns has been very skilful. In spite of the necessary defects of material derived from what untrained observers tell about their own mental states, the broader features of growth—those upon which general pedagogical practice must be based—are adequately set forth.

The volume is significant of new scientific attitudes and occupations. It means nothing less than that the *modus vivendi* with theology whereby two supposedly distinct fields of study were delimited, has come to an end. Theology moved in this direction when it adopted scientific methods in the study of the Scripture and in the history of religions. And now science also throws off her reserve and, agreeing with Karl Pearson that wherever facts can be observed and compared, there is the realm of science, assumes that 'there is no event in the spiritual life which does not occur in accordance with immutable laws' (Starbuck, p. 3).

However much this may look like an 'invasion' of religion by science, it is, in fact, in logical harmony with the theology of divine immanence, which denies the mutual exclusiveness of the natural and the supernatural and finds it worthy of supreme intelligence that nature and mind should proceed by orderly sequence. It is certainly to be hoped that both theologians and men of science will take this view of the matter, and thereby avoid such unfortunate squabbles as accompanied the adoption of the new geology and of the evolution hypothesis. On the side of science all that is required is that law be understood in the sense of uniformity and not in the sense of a controlling necessity.

There are three reasons for expecting that studies like this will be assimilated by religious thinkers with some degree of readiness. The first is that the contest over geology and evolution has taught its lesson. The second is that Starbuck's spirit and attitude show no trace of antagonism to religion or religious beliefs. A third reason is that the book furnishes a preliminary basis for a sound religious pedagogy and contains tools capable of being used for religious propagandism. The 'dead hand' of false method has been upon the practical work of the churches as truly, if not as fully, as upon their theology. Analysis of human nature as it presents itself to observation has scarcely been heard of except in the training of Jesuits, and here it is only a device for attaining certain prescribed ends. The Protestant churches, at least, will find their interest in promoting such studies as that before us. Denominational colleges will find that they have a special call to prosecute them, and in the end we may hope to see shambly Sunday-school methods and hit-or-miss evangelism superseded by a reasonable system of religious training and an evangelism that has conscious respect for ascertainable facts of human nature.

The effect of the ancient misunderstanding between science and religion could not be slight. In early Greek thought what we now call science was all one with what we now call philosophy and with the intellectual side of religion. The sciences have been completely segregated from other intellectual interests, in fact, scarcely more than a century. No doubt science and religion have both gained by the separation, but it may reasonably be asked whether their going apart, is not, after all, a merely temporary expedient to enable the intellect to regain its unity upon a higher plane.

GEORGE A. COE.
NORTHWESTERN UNIVERSITY.

BOOKS RECEIVED.

The Cell in Development and Inheritance. EDMUND B. WILSON. New York and London, The Macmillan Company, 1900. Pp. xxi + 483.

Lehrbuch der Zoologie. RICHARD HERTWIG. Jena, Gustav Fischer, 1900. Pp. xii + 622. 11 Mark, 50 Pf.

Catalogue of the Fossil Bryozoa in the Department of Geology, British Museum (Natural History), Volume I. *The Cretaceous Bryozoa.* J. W. GREGORY. London, The British Museum, 1899. Pp. xiv + 457 and seventeen plates.

Catalogue of the Arctiadæ. SIR GEORGE F. HAMPSON. London, The British Museum, 1900. Pp. xx + 589.

A Monograph of Christmas Island, Physical Features and Geology. CHARLES W. ANDREWS. London, The British Museum, 1900. Pp. xiii + 337. A map and twenty-two plates.

Anatomie et physiologie végétales. ER. BELZUNG. Paris, Alcan, 1900. Pp. iii + 1320.

Micro-organisms and Fermentation. ALFRED JÖRGENSEN. Translated by ALEX. K. MILLER and A. E. LENNHOLM. London and New York, The Macmillan Company, 1900. Pp. vi + 318.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Journal of the Boston Society of Medical Sciences* for April opens with an abstract of the 'Histology of Acute Pneumonia,' by Joseph H. Pratt, giving a summary of the examination of fifty cases. G. B. Magrath has a preliminary study of 'The Relation of Age, Physique, and Preliminary Training to Class Rank in Pathology,' training not unnaturally seeming to have the most marked bearing on scholarship. F. P. Denny presents a 'Report on the Examination for Diphtheria Bacilli of Cultures from Four Hundred and Seventy-five Individuals,' an important conclusion being that while such bacilli are rarely present in healthy persons, a large number may be infected by healthy individuals who *do* have the bacilli in their throats. J. H. Wright describes 'A Case of Multiple Myeloma,' and Franklin Dexter has some 'Additional Observations on the Morphology of the Digestive Tract of the Cat,' while Wm. Hallock Park gives the results of 'A Few Experiments upon the Effect of Low Temperatures and Freezing on Typhoid Bacilli,' showing that they possess great powers of endurance and that infection may be caused in spring by fecal material thrown out in winter. The final paper, by E. W. Taylor, describes a case of 'Diffuse Degeneration of the Spinal Cord.'

THE *Popular Science Monthly*, established in 1872 by Messrs. D. Appleton & Co. and Dr. E. L. Youmans, will hereafter be published by Messrs. McClure, Phillips and Company and edited by Professor J. McKeen Cattell. The table of contents for June is as follows:

The Progress of Science: The Retiring President of the National Academy; The Work of the Academy; The American Association; An International Assembly; A National Physical Laboratory; The Promotion of Men of Science; Recent Deaths; The Solidification of Hydrogen; Chemical Fertilization; The Approaching Eclipse.

SOCIETIES AND ACADEMIES.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

AT the regular meeting of the New York Section of the American Chemical Society, held May 12th at the Chemists' Club, the following papers were read:

C. W. Volney: 'New Extraction Apparatus.'

C. W. Volney: 'Artificial Musk.'

P. A. Levene: 'Modern Researches on the Chemistry of the Proteid Molecule.'

J. A. Mathews: 'Calticyanides of Bismuth.'

Dr. Volney's artificial musk was exhibited and caused considerable discussion. It is said to be a compound belonging to the paraffine series, and therefore a distinct departure from the idea that an artificial perfume must contain the 'benzol ring.' No analysis was given nor particulars of the method of preparation, these being reserved for a future communication.

Asked whether his musk is composed of a saturated or unsaturated paraffine compound, Dr. Volney said it is saturated.

Dr. Schweitzer said that so far as he knew, it had never been claimed that an aromatic group was necessary in the synthetic musks. Patents had been taken out for a variety of processes, some for preparing musks by nitrating resins, among them ordinary rosin; but when the inventor had been asked to supply his musk on a large scale he had furnished 'musk Baur.'

Dr. Stearns claimed that nitrated bodies do not smell of true musk. Different persons, he said, are differently affected by the true musk odor, and many are incapable of deciding that an imitation is a good representative of the true odor. In this way many substances were called artificial musk which would not pass even an arbitrary set of tests. It is not yet known what the essential element of true musk is, or whether it is pre-existent, or is formed by a slow chemical change in the constituents of musk material. Baur has examined musk to determine whether nitrated bodies were present, but found none.

Dr. Levene's paper was an interesting review of the work which has been done and the views which have been held during the past two years on the chemistry of the protein compounds and the classifications of their constituents.

In regard to the sulphur in their composition, he said it evidently existed in two forms or conditions of combination, one molecule being separable as hydrogen sulfide, the other remaining.

Dr. J. A. Mathews described an investigation of the cobalticyanides of bismuth designed to develop a process for separation of bismuth in analytical work, for instance in the analysis of pig and refined lead. The conditions under which such an analysis are carried out were found, however, to prevent the complete precipitation of bismuth as cobalticyanide, and as yet he had not been able to make the practical application of the study of these salts which had been hoped for.

The meeting was addressed by Professor Rising, of California, who said that much interest was manifested by the chemists of the Pacific coast in becoming members of the American Chemical Society, and an application for a charter would soon be made.

Dr. McMurtrie, president of the Society, was present, and, invited to take the chair, said that in view of the approaching general meeting it was necessary that each member should bring out whatever subject he had in readiness for publication in time to have its title announced on the program. All such titles should be transmitted to the General Secretary, A. C. Hale, 551 Putnam Avenue, Brooklyn, N. Y., as early as practicable, to facilitate the preparation of the program and to enable the committee to arrange sufficient time for the sessions.

Dr. Doremus announced the full list of sections and ground covered thereby in the congress of chemists to be held at Paris in July; also that titles of papers to be presented there should be forwarded not later than June 1st.

DURAND WOODMAN,
Secretary.

CHEMICAL SOCIETY OF WASHINGTON.

THE regular meeting was held April 12, 1900.

The first paper of the evening was read by Mr. J. K. Haywood, and was entitled 'The Analysis of the Arsenical Insecticides.'

The paper consisted of the comparative study of various methods proposed for the analysis of these preparations.

The second paper of the evening, which was presented by Dr. H. C. Bolton, entitled 'A Claim for Priority,' was read by the Secretary.

The Journal of the American Chemical Society for March, 1900, contains a paper by Joseph W. Richards and Norman S. Powell, entitled 'Substitutes for Hydrochloric Acid in Testing Carbonates'; the authors find that potassium acid sulfate, oxalic acid, citric acid and tartaric acid can be used in testing carbonates, producing effervescence more or less actively and they give a table of results. The authors make no reference to previous work on the same lines, and this prompts me to claim that about twenty years ago I anticipated all their observations and published the results in periodicals accessible to everyone.

Between 1887 and 1882 I published three memoirs under the title 'Application of Organic Acids to the Examination of Minerals,' in which I showed the action of these acids on 200 mineral species, including carbonates, sulfids, oxides, silicates and many others. I pointed out the usefulness of citric acid as a substitute for hydrochloric acid in the laboratory and in the field, and showed that by means of it certain minerals could be readily distinguished.

These papers were printed in whole or in part in the following journals: *Chemical News*, Vols. 35, 36, 43 and 47; *Annals N. Y. Acad. Sciences*, Vols. I. and II.; *Proceedings American Assoc. Adv. Science*, Vol. 47; *Reports Brit. Assoc. Adv. Science*, Vol. 50; *Mineralogical Mag.*, Vol. IV.; *Berichte d. d. chem. Ges.*, Vol. XIII.; and abstracts appeared in many other journals. Moreover, the use of citric acid in testing minerals was adopted by teachers in more than one scientific school, the use of potassium acid sulfate having been long known before. Finally, Nason's edition of Elderhort's *Manual of Qualitative Blowpipe Analysis* (1881) gives a whole chapter to my method.

It is gratifying to note that the results obtained by Richards and Powell agree well with mine. Coincidences of independent thought often occur, but in publishing a research some acknowledgment of previous work is generally made; had the authors made even a slight examination of familiar literature they would have found that their field of study had been thoroughly traversed.

The third paper was read by Dr. Cameron and was entitled, 'The Estimation of the Carbonates and Bicarbonates of the Alkalies,' by F. K. Cameron and L. J. Briggs.

The last paper was read by Dr. Cameron and was entitled 'The Solubility of Calcium Sulfate in Solutions of other Salts,' by F. K. Cameron and F. D. Gardner.

Mr. Chestnut exhibited specimens of plants used by the Indians in California to stupefy fish which they use for food.

An adjourned meeting was held at Hopkins Hall, Johns Hopkins University, Baltimore, Md., on April 21, 1900.

Dr. Remsen welcomed the society and explained that the Chemical Department of the University is now undergoing repairs after damage by fire. He gave an interesting account of the work in progress under his direction in the University laboratory.

The first paper was read by Dr. Simon and was entitled 'A Storage Vessel for Solid Carbon Dioxid.' The author exhibited an improved vessel, which he had designed and which is giving universal satisfaction in the transportation of such materials as solid carbon dioxid and liquid air. In connection with the vessel he exhibited some solid carbon dioxid which had been placed in it the day before and showed that there had been very little loss.

Professor Morse read a paper on the preparation of permanganic acid, in which he discussed various methods and showed that the electrolytic method had been most satisfactory. He described in detail the apparatus used in his laboratory for carrying out this method.

Dr. Bolton presented a paper entitled, 'An Experimental Study of Radio-active Substances.' The paper was illustrated with photographs taken with Radium light.

The last paper of the evening was read by Dr. F. W. Clarke and was entitled: 'The Action of Ammonium Chlorid on Certain Silicates' by F. W. Clarke and George Steiger.

A brief outline of the method of decomposition of some zeolites by heating with ammonium chloride in a sealed tube, was first given. It was shown by the experiments that two of the formulæ hitherto given, to Scolecite, Natrolite and Prehnite must be abandoned. Scolecite and Natrolite give almost identical ammonium compounds, calcium having been replaced in the one case and sodium in the other. They also show these two zeolites to be probably salts of orthotrisilicic acid. In the case of Prehnite the results were quite different, two experiments giving only .17 per cent. in the one case and .22 per cent in the other, of ammonium, in the product formed by their treatment. This different action shows that Prehnite can no longer be classed with the former two. In the case of Pectolite the results were so irregular that definite conclusions could not be drawn from the facts at hand. Some figures were given and a formula suggested.

WILLIAM H. KRUG,
Secretary.

BIOLOGICAL SOCIETY OF WASHINGTON.

THE 325th regular meeting, the last for the season, was held on Saturday evening, May 19th. Mr. C. H. Townsend spoke at length on 'The Recent Cruise of the *Albatross* among the South Pacific Islands, with Remarks on the Inhabitants and their Customs,' illustrating his remarks with numerous lantern slides. The speaker described the route followed, the method of sounding and dredging, and noted the additions made to our knowledge of the depth of the ocean. The peculiarities of some of the islands were given, including those of the typical atolls. Mr. Townsend then described the inhabitants of some of the groups of islands visited, calling attention to the fact that each group possessed its own type of house and canoe. In conclusion the speaker gave an account of his trip across the island of Fiji, giving high praise to the manner in which the group was ruled by the English.

F. A. LUCAS.

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON.

THE 305th regular meeting of the Anthropological Society was held Tuesday, April 24, 1900.

The meeting was designed as a memorial of Frank Hamilton Cushing, Vice-President of the Section of Technology, whose recent death had deprived the Society of one of its most brilliant members.

The following resolutions, prepared by a committee of the Board of Managers of the Society, were presented:

WHEREAS, Our colleague and friend, Frank Hamilton Cushing, Vice-President of the Section of Technology in the Anthropological Society of Washington, has been removed from our midst by death—

Resolved, That the members of the Anthropological Society of Washington unite in an expression of deep sorrow at his untimely death. An enthusiastic investigator, an acute observer, a genius in grasping the thoughts of primitive men, a master in exposition, and a tireless worker, his contributions to the science of man are many and brilliant.

To unravel and correlate the fading myths of a well nigh extinct race, he gave the best years of his unselfish life, braving disease, danger and death itself in his work as a pioneer; and in his death while yet in his prime and in the midst of his noblest work the science has suffered a grievous loss. An active member of this Society from its foundation, he was a frequent contributor to our proceedings; his contributions were of surpassing originality, embodying rich and unique experience and the results of profound study, always expressed in felicitous form; so that his death closes forever one of our richest sources of instruction and inspiration.

The loss to the science and our Society is a loss to mankind; the world is poorer to-day because the life of Frank Hamilton Cushing has passed from it.

To his bereaved family and sorrowing friends we tender our heartfelt sympathy.

J. H. MCCORMICK,
P. B. PIERCE,
W. H. HOLMES,
Committee.

Addresses giving various phases of Mr. Cushing's life and work were then made by President W J McGee, Major J. W. Powell, of the Bureau of Ethnology, in which Bureau Mr. Cushing was a brilliant worker, Mr. L. O. Howard, Secretary American Association for the Advancement of Science, who was a classmate in Cornell; Professor W. H. Holmes, spoke of his work for the National Museum; Mr. Stuart Culin, of his researches in behalf of the University of Pennsylvania; Mr. J. D. McGuire, of his genius in the technological and archæological field; Dr. Washington Matthews, of his discoveries in Zuni and the Salado Valley and of his organization and explorations with the Hemenway expedition; Mr. P. B. Pierce, of his character as a personal friend; Miss Alice C. Fletcher, of Mr. Cushing's wonderful mind and his ability to discern similarities and forge the connecting links between the thoughts of primitive man and the archæic remains with which he was surrounded. The consensus of opinion was that Mr. Cushing occupied a field peculiarly his own and that he ranked as one of the few real geniuses of the world.

Letters of regret were read from Dr. Franz Boaz, of the American Museum of Natural History and Mr. Wm. Wallace Tooker and Wells M. Sawyer.

The resolutions were adopted by a rising vote.

J. H. McCormick.
Secretary.

DISCUSSION AND CORRESPONDENCE.

HUMANIZING THE BIRDS.

Bird Lore for December last contained an excellent article by Caroline G. Soule, entitled 'Humanizing the Birds,' and protesting against the too common practice of ascribing to them human qualities which they do not possess and mental traits with which they are not endowed. The title might well serve as the text for a long discourse on the subject, for there is all too much of this 'humanizing' indulged in now-a-days, not only by those who write about birds, but by writers in all branches of natural history, and it is not confined to stories written for the instruction of small children, but in articles intended for the edification of children of a much larger growth. Writers on evolution are all too prone to humanize their subjects, and it is so favorite a sin with those discussing problems of mimicry that in his *Dictionary of Birds* Professor Newton follows that caption 'with the prefix UNCONSCIOUS, which in every department of zoology should always be expressed or understood.' For it is a common fault to make the mimicking process active instead of passive, to say, for example, that "Many butterflies escape destruction by mimicking the colors and markings of uneatable forms," as if the butterflies had given serious thought to the matter. When an author writes that "Butterflies are often attracted by the excreta of birds and a spider takes advantage of this fact to secure his prey," he implies a considerable amount of reasoning power in the spider. That this implication is not intended is shown a little later by the statement that "The whole combination of habits, form and coloring afford a wonderful example of what natural selection can accomplish," but the damage has been done and the suggestion made that the mimicry is intentional.

When we read that the "witch-hazel, knowing that neither boy nor girl, nor bird nor beast nor wind, will come to the rescue of its little ones, is obliged to take matters into its own hands" we realize that it was written for a child, although we may deplore this manner of writing and wish that the case had been differently stated. But here is a statement almost, if not quite as bad, taken from an important work on zoology and not written with the view of interesting a child: "In the Mediterranean the embryos [of sponges] * * * escape from the tissues of the parent when they have arrived at the blastula condition * * *, in the same species on the shores of the English Channel the young are retained until after gastrulation * * *." The explanation of this it is said is not difficult: "In the Mediterranean there are no strong currents and is evidently best for the parents to get rid of the young at as early a moment as possible, thus escaping longer drain upon its energies. In the English Channel, on the other hand, the current is very strong, and were the embryos to be set free at the stage at which they are in the Mediterranean the chances are that they would be swept away * * *, *and hence they are retained* (italics ours) until nearly ready for attachment to the rocks." This seems to be a direct transposition of cause and effect and credits the lowly sponge with an amount of reasoning power and a degree of intelligence that few have suspected it to possess. Why would it not have been quite as accurate and decidedly less confusing to have said that, while we do not *know*, it seems probable that in the first case we have the normal condition of affairs, while in the second there has been an elimination of those sponges whose young were turned loose into a cold world at too tender an age?

These are merely one or two examples, the first that came to hand, of a very prevalent style of writing, but they serve as typical examples of a familiar class. Such statements as these are made with a view of popularizing science by making it pleasant reading, but it may be questioned if this mode of writing does not merely fail of producing its intended effect, but creates an entirely erroneous impression in the minds of the non-scientific reader for whom it is meant. Does it not teach that evolution is not a passive but an active process, and subtly lead him to think that not only the higher, but the lower animals, even the plants, pass many anxious moments considering what they may do for the benefit of posterity? Sooner than leave such an impression as this it would seem best to cease 'humanizing the birds.'

F. A. LUCAS.

NOTES ON INORGANIC CHEMISTRY.

IN the last number of *Nature*, W. A. Shenstone and H. C. Lacell, of Clifton College, contribute an interesting paper on working silica in the oxy-gas blow-pipe flame. While Gaudin had observed the elasticity of fine threads of vitreous silica as early as 1839, it was not till Professor C. V. Boys rediscovered the valuable qualities of 'quartz threads' in 1887 that the working of silica in the blow-pipe flame became practical. The authors have done much work with silica which is described in the paper. They find it possible to make thermometer tubes of silica and express the view that the only limit in its application is the matter of expense. They note in conclusion certain properties: It is harder than feldspar, but less hard than chalcedony, and its surface appears equally hard, whether cooled rapidly or slowly; the cold vitreous silica can be plunged safely into the hottest part of the oxy-gas flame, and thick rods and tubes of silica can be heated till plastic and then plunged into cool water without injury; vitreous silica is a very poor conductor of heat and hence it is possible to hold a thick rod of silica very close to a strongly ignited zone. Great developments in chemical and physical laboratories may be expected when it becomes possible to use apparatus of silica, which, in addition to possessing an extreme resistance, will endure the greatest and most rapid variations of temperature.

IN a paper read before the Royal Society of Dublin, by James Holmes Pollok, a new deposit of kieselguhr is described as occurring in County Antrim, along both banks of the Lower Bann from Toome Bridge, where the river emerges from Lough Neagh, down to Coleraine at its mouth. The deposit rests on peat and is only covered by vegetation. In places it is four feet in thickness. After drying in the sun, the material is pure white, porous and very light, the specific gravity of the mass being only 0.5422. The deposit is probably now being augmented when the river overflows its banks, and is largely composed of cubical diatoms from Lough Neagh.

A PAPER in the *Zeitschrift für anorganische Chemie*, by W. Hempel and v. Haasy, on amorphous silicon brings out several new facts in an old subject. By the action of sodium on the fluorid of silicon and subsequent fusion of the powdered mass with aluminum, a very active form of amorphous silicon is obtained on dissolving out the aluminum. This silicon burns very readily when heated gently in the air. Heated in chlorin it gives easily silicon chlorid. By direct union with sulfur, silicon disulfid is formed, which is purified by sublimation, forming long white needles, similar to the product described by Sabatier as being formed by heating silicon in a current of hydrogen sulfid. On fusion with sodium sulfid, sodium metathiosilicate Na_2SiS_3, is formed corresponding to sodium thiocarbonate. When treated with chlorin the chlorids of sulfur and silicon are formed and this reaction is used by the authors to detect thiosilicates in natural and artificial silicates. Thus they find 0.007 per cent. of SiS_2 in Vesuvius lava, up to 0.1 per cent. in different blast furnace slags, and 0.174 per cent. in ultramarine. They suggest that the sulfur in many sulfur springs may be due to the decomposition of thiosilicates.

THE last *Chemical News* contains the translation of a paper on krypton, communicated to the Berlin Academy by Professor Ludenburg and Professor Kruegel, of Breslau. Availing themselves of the possibility of obtaining larger quantities of liquid air, they examined the residue of 850 liters. These liters of this liquid residue gave 2300 liters of gas which was freed from oxygen and nitrogen. The final residue of 3.5 liters of gas was condensed in liquid air and then fractioned. The earlier fractions were chiefly argon, though even the second of the six fractions showed clearly the green krypton line. After the fifth fraction was boiled off there remained a crystalline residue melting at about —147°. The gas in this fraction proved to be nearly pure krypton, though some argon lines were present in the spectrum. Ramsay had suggested for krypton the density of 80–82, but two determinations with Ladenburg's krypton gave 58.67 and 58.81, using about 16 c.c. of the gas which had been crystallized. The authors suggest for the inert gases a position before Group I. as follows: Helium = 4 before lithium, neon = 20 before sodium, argon = 39 before potassium, and finally krypton = 59 before copper. The authors are continuing their researches which promise interesting results.

J. L. H.

CURRENT NOTES ON PHYSIOGRAPHY.

THE DIVERSION OF THE YELLOWSTONE.

THE questions raised by the unequal development of different parts of the Yellowstone drainage system within the National Park, as shown upon the topographic maps of the U. S. Geological Survey (see SCIENCE, V., 1897., 577), are answered by J. P. Goode in an article on 'The Piracy of the Yellowstone' (*Journ. Geol.*, vii, 1899, 261–271). It is there explained that the postglacial discharge of Yellowstone lake, when it stood about 200 feet higher than to-day, was orignally southwestward through a deep notch between Overlook and Channel mountains to the head of Snake river. The lower part of the canyon by which the lake is now discharged northward was then like its several neighbors in the rhyolite plateau, occupied by an active stream whose length was increasing by headward erosion. More favored than its fellows, this stream happened to gnaw through the divide that previously enclosed the lake basin and thus the waters of the lake were diverted to a northward discharge. The canyon was rapidly deepened, and the former outlet to the Snake river was abandoned. To-day the floor of the old outlet is poorly drained; puny streams start on its marshy course and flow to the opposite oceans. The falls in the new canyon are ascribed to the resistance of an undecomposed portion of rhyolite, on which the erosion of the river is retarded.

This essay does not explain the origin of the deep channel by which the lake was discharged to Snake river. The mountains in which the channel was cut seem to have been originally much higher than the divide through which the Yellowstone canyon has recently been eroded. On this point we may have fuller details in the expected Survey monograph on the Yellowstone Park.

MILL ON SOUTHWEST SUSSEX.

DR. H. R. MILL, librarian of the Royal Geographical Society of London, proposed several years ago that a detailed geographical description should be prepared for the sheets of the one-inch English ordnance survey (see SCIENCE, III., 1896, 799). He has now made a first contribution to the scheme in 'A Fragment of the Geography of England: Southwest Sussex' (*Geogr. Journ.*, xv, 1900, 205–227, 353–373), a compendious account of the various features of that interesting district. The essay and its illustrations are excellent in many respects, and called forth deserved praise when presented at a meeting of the Society; but the pages that are concerned with physiography leave something to be desired, inasmuch as they do not cover their subject broadly or uniformly. The 'fragment' includes a part of the South Downs, a monoclinal ridge of chalk that forms the southern enclosure of the denuded area of the Weald. The ridge is trenched by the consequent valley of the Arun, an excellent example of its class; yet the Arun is merely said to be 'a typical river of the Weald,' leaving the uninformed reader entirely in the dark as to the features that it typifies, although a paragraph is allowed to the no more important matter of a comparison of Selsey bill, with two other salients of the south coast. The beautiful meanders of the Arun in its transverse valley through the Downs are passed over without explanation and without reference to similar features elsewhere, although the square cross-roads of Chichester are interestingly explained as of Roman origin, and the mean values of hours of sunshine and of atmospheric pressure are properly stated in relation to the values that obtain in other parts of Britain. As to the origin of the Arun valley, we find only the skeptical statement that it "might possibly be explained by supposing that the river * * * course was determined by the original dip slope of the Wealden Dome." Cocking pass, a notch in the Downs west of the Arun gorge in all probability marks the former path of a consequent stream whose head-waters have been diverted to the Arun system by the subsequent Rother, yet no mention is made even of the possibility of such a change, although space is found for Reid's venturesome theory that the dry valleys of the Downs were formed during 'the end of the glacial period,' when the usually pervious chalk 'was frozen into hard and impervious rock in which the torrents resulting from the melting of the higher snow cut out the valleys'; no consideration being here given to the work of ordinary subaërial erosion on the chalk during a preglacial time that was long enough to witness the excavation of the interior lowland of the Weald.

Dr. Mill's paper contains a large amount of well chosen and well presented material. It will probably be taken as a model upon which later essays will be framed. It is therefore all the more to be regretted that physiographic description was not more fully and systematically supplemented by explanation, and that the many local types of land and water forms were not presented as members of their class, rather than as (apparently) isolated examples.

THE PESCADORES ISLANDS.

The Pescadores or Hoko islands, lying between Formosa (Taiwan) and the Chinese coast, are described by Koto (Notes on the Geology of the dependent isles of Taiwan, *Journ. Coll. Sci., Imp. Univ., Tokyo*, xiii, 1899, pt. 1) as the ragged remnants of a series of nearly horizontal basalt sheets with intercalated strata of supposed Tertiary age. The islands and islets, 57 in number (besides countless reefs and ledges), are low and tabular or mesa-like, with deep weathered soil on the uplands. Their original area has been much lessened erosion, especially by the attack of the waves, as the uplands descend to the irregular shore line in steep slopes, broken at different levels by the edges of thin basalt sheets. The surface is barren and desolate, 'a quasi-desert, and not an oasis, amidst the green island-world of south-eastern Asia,' a condition that is attributed to the savage violence of the wind, which blows from the northeast during three quarters of the year. The rains of the southwest winds in summer sink into the ground, forming few streams; erosion at present is chiefly performed by the winds and waves. Fringing and barrier coral reefs grow nearly all around the island upon the basaltic shelf.

W. M. DAVIS.

CURRENT NOTES ON METEOROLOGY.

CLIMATE OF SAN FRANCISCO.

UNDER the direction of the present Local Forecast Official of the Weather Bureau, at San Francisco, Mr. A. G. McAdie, special attention is being paid to studies of local climates in California. The *Monthly Review of Climate and Crops: California Section*, has thus lately contained reports upon the climates of Eureka, Fresno, Los Angeles, Sacramento, San Bernardino, San Diego, San Francisco, Stockton and Visalia. Now there has been issued *The Climate of San Francisco, Cal.*, as Bulletin No. 28, of the Weather Bureau, prepared by A. G. McAdie and G. H. Willson. The records which have been studied go back, in the case of the monthly and annual rainfalls, to 1849, while the temperature record begins in 1871. The warmest month at San Francisco is September, with 60.9°, the coldest is January, with 50.1°. The highest temperature ever recorded was 100°, on June 29, 1891, and the lowest was 29°, on January 15, 1888. A comparison of the observations at San Francisco with those made at the Weather Bureau Station at Mt. Tamalpais (2373 ft.) brings to light several interesting facts. During June, 1899, the temperature *rose* at the average rate of 1° in every 203 feet of elevation between San Francisco and the mountain station. Fogs seem to occur at times of steep inverted gradients, when the temperature at 2500 feet is considerably higher than at sea level. The annual rainfall is 23 inches. The largest yield of crops follows a generous rainfall in March and April. The average number of clear days is 149; of partly cloudy days, 137, and of rainy days, 69.

KÖPPEN'S KLIMALEHRE.

KÖPPEN'S *Klimalehre* is a compact summary of the principles of climatology. It is a small octavo volume of 122 pages and 7 plates, and therefore cannot for a moment be compared with Hann's *Handbuch der Klimatologie* as regards completeness of presentation and breadth of view. Köppen's little book will, however, serve very well for those who wish to learn something of general climatology without going far into the subject. Considering the very limited size of the volume the matter is admirably presented. The book appears in the *Sammlung Göschen* (Leipzig, 1899. Price, 80 Pfgs.), in which collection there has already been published Trabert's *Meteorologie*, also an excellent brief discussion of the essential portions of the subject with which it deals.

DESTRUCTION OF BIRDS BY A HURRICANE.

Nature for April 5th notes a remarkable fact in connection with the West Indian hurricane of September, 1898. It appears that before the hurricane one of the tamest and commonest birds on the island of St. Vincent was a small humming-bird, but none of these birds have been seen since September, 1898. Other humming-birds, which were formerly less common than the one now missing, are still to be seen in St. Vincent, but in diminished numbers. The bird which has thus apparently been exterminated was the smallest of the three species known on the island, and hence probably also the most easily killed.

THE JUNGFRAU RAILWAY AND MOUNTAIN SICKNESS.

AN interesting note in connection with the physiological effects of diminished pressure at high altitudes is contained in an article on the Jungfrau railway, published in the *Engineering Magazine* for April. The work of construction is now being carried on very largely by Italians, but when the tunnel reaches an altitude of about 3000 meters it is considered almost certain that Swiss mountaineers will have to be employed. The latter will, it is believed, be far better able to do the necessary hard labor at the greater altitudes.

A REMARKABLE DIURNAL RANGE OF TEMPERATURE.

Ciel et Terre, for April 16th, contains a record of an extraordinary diurnal range of temperature observed in Mongolia during the year 1898 by the traveller M. Zichy. At Urga the thermometer at 5 A. M. stood at 30.2°, while the temperature at noon was 105.8°.

R. DEC. WARD.

HARVARD UNIVERSITY.

THE CONGRESSES OF THE PARIS EXPOSITION.

MORE than one hundred and fifty International Congresses, dealing with various subjects of scientific, industrial and social importance, are to be held this summer in Paris, and will form no small part of the interest of the Exposition, supplementing as they do the exhibits, furnishing the theory, as the exhibits set forth the accomplishments, of art and industry.

The delegates will be divided into three classes, those who officially represent the Government, the representatives of local and national organizations, and those who attend out of personal interest purely, the two latter classes paying a membership fee varying usually from two to five dollars. As all Congresses, even those of a permanent character of long standing, such as the Congresses of Medicine, Geology and Chemistry, will be held this year under the auspices of the Exposition, many of them meeting within the Exposition grounds in the Palais des Congrès erected especially for this purpose. The official delegates will be accredited by the Commissioners General, acting on behalf of the president or monarch of their respective countries.

Commissioner Peck has recognized the importance of this feature of the Exposition and the permanent value which comprehensive reports of the deliberations of these bodies would represent, and with this idea in view a systematic propaganda has been carried on under the direction of Professor J. Howard Gore, of Columbian University, Washington, D. C., as Director of the Department of Organization of International Congresses, with the result that about one hundred and fifty persons, eminent in their several specialties, have been accredited as delegates. In this work the Governmental Departments have been first consulted, then local and national organizations and individuals.

It is suggested that all men of science who attend these congresses, in whatever capacity, register at the office of the Director, at No. 20 Avenue Rapp, Paris. Those in charge will take pleasure in giving all information in their possession concerning the programs, places of meeting, proposed fêtes and excursions in connection with the Congresses, etc., and may thus be able to put persons with whom they have not previously corresponded, in touch with such Congresses as may be most congenial and profitable.

We have already published details regarding many of the congresses but the following list giving the complete list in chronological order will prove useful to those visiting the Exposition this summer.

May	25–27.	Horticulture.
June	4– 7.	Forestry.
	4– 7.	Movable Property.
	8–11.	Joint Stock Companies.
	11–13.	Landed Property.
	11–13.	Aid Societies of Working Youth.
	14–16.	Teaching of Agriculture.
	14–16.	Numismatics.
	18–21.	Comparative History.
	18–20.	Agricultural Stations.
	18–21.	Cheap Dwellings.
	18–25.	Mines and Metallurgy.
	18–23.	Women's Work and Institutions.
	20–23.	Viticulture.
	21–23.	Cattle-feeding.
	25–30.	Insurance.
	25–30.	Actuaries.
	25–30.	Labor Accidents and Society Insurance.
	26–30.	Ornithology.
July.		Chronometry.
	1– 7.	Agriculture.
	8.	Agriculture Co-operation.
	8–10.	Peoples' Credit Bank. (Loan Societies, etc.)
	9.	Aeronautics.
	9.	Automobiles.
	9–13.	Prisoners' Aid Societies.
	9–16.	Testing of Materials.
	10–18.	Profit-Sharing.
	11–13.	Workmen's Co-operative Productive Associations.
	15–18.	Profit Sharing.
	16–18.	Steam Engines, etc.
	16–20.	Teaching of Social Science.
	17–23.	Life Saving.
	18–21.	Commercial Schools.
	18–21.	Homeopathy.
	18–22.	International Co-operative Alliance.
	19–21.	Naval Architecture and Construction.
	19–25.	Applied Mechanics.
	23–28.	Meteorology.
	23–28.	Professional Medicine.
	23–28.	Photography.
	23–29.	Commerce and Industry.
	23–28.	Industrial Property Right.
	23–31.	Applied Chemistry.
	24–29.	Teaching of Living Languages.
	30–Aug. 4.	Architecture.
	30–Aug. 4.	Colonial Sociology.
	30–Aug. 4.	Regulation of Customs.
	28–Aug. 3.	Navigation.
	30–Aug. 4.	Tariff Regulations.
	30–Aug. 4.	Higher Education.
	30–Aug. 5.	Poor Relief.
	30–Aug. 5.	Public and Private Charities.
	31–Aug. 4.	Comparative Law.
August.		Music.
		Municipal Art
		Stage.
	2– 8.	Pharmacy.
	2– 5.	Primary Education.
	2– 5.	Secondary Education.
	2– 7.	Philosophy.

2– 9. Medicine.
2– 9. Dermatology.
5– –. Blind.
6– 8. Deaf Mutes.
6– 8. Anti-Slavery.
6– 9. Housing.
——. Red Cross.
6–11. Colonial.
6–11. Mathematics.
6–11. Physics.
6–11. Technical and Industrial Education.
8–14. Dentistry.
9–15. Stenography.
9–11. Educational Press.
10–17. Hygiene and Demography.
10–18. Bibliography.
12–14. Alpinists.
12–15. Hypnotism.
16–28. Geology.
18–25. Electricity.
20–25. Anthropology and Prehistoric Archæology.
22–25. Psychology.
25–Sept. 1. Ethnography.
27–31. Economic and Commercial Geography.
29–Sept. 1. Teaching of Art.
29–Sept. 1. Teaching of Design.
29–Sept. 1. Teaching of Drawing.
30–Sept. 6. Physical Education.

September. Gold and Silver.
2–8. Ethnographical Sciences.
3–5. Basque Studies.
3–8. History of Religions.
5–8. Women's Rights.
6–9. Social Education.
10–12. Apiculture
10–12. Fruit Culture.
10–12. Folklore.
10–13. Popular Education.
14–19. Aquiculture and Fishery.
15–23. Railroads.
17–21. Americanists.
24–29. Fisheries.
25–28. Sunday Rest.
29–6. Peace.

October. 1–3. Maritime Law.
1–7. Botany.
Fireman (officers).
Medical Press.
Thread Numbering (textile).
Tramways (street railways).

ANTI-VIVISECTION LEGISLATION.

THE following letter from President Eliot of Harvard University to the Hon. James McMillan, Chairman of the Senate Committee of the District of Columbia, is printed in the medical journals:

HARVARD UNIVERSITY,
CAMBRIDGE, March 19, 1900.

Dear Sir:—I observe that a new bill on the subject of vivisection has been introduced into the Senate, Bill No. 34. This bill is a slight improvement on its predecessor, but is still very objectionable. I beg leave to state very briefly the objection to all such legislation.

1. To interfere with or retard the progress of medical discovery is an inhuman thing. Within fifteen years medical research has made rapid progress, almost exclusively through the use of the lower animals, and what such research has done for the diagnosis and treatment of diphtheria it can probably do in time for tuberculosis, erysipelas, cerebro-spinal meningitis, and cancer, to name only four horrible scourges of mankind, which are known to be of germ origin.

2. The human race makes use of animals without the smallest compunctions as articles of food and as laborers. It kills them, confines them, gelds them, and interferes in all manner of ways with their natural lives. The liberty we take with the animal creation in using utterly insignificant members of them for scientific researches is infinitesimal compared with the other liberties we take with animals, and it is that use of animals from which the human race has most to hope.

3. The few medical investigators can not, probably, be supervised or inspected or controlled by any of the ordinary processes of Government supervision. Neither can they properly be licensed, because there is no competent supervising or licensing body. The Government may properly license a plumber, because it can provide the proper examination boards for plumbers; it can properly license young men to practice medicine, because it can provide the proper examination boards for that profession, and these boards can testify to the fitness of candidates, but the Government can

not provide any board of officials competent to testify to the fitness of the medical investigator.

4. The advocates of anti-vivisection laws consider themselves more humane and merciful than the opponents of such laws. To my thinking these unthinking advocates are really cruel to their own race. How many cats or guinea pigs would you or I sacrifice to save the life of our child or to win a chance of saving the life of our child? The diphtheria-antitoxin has already saved the lives of many thousands of human beings, yet it is produced through a moderate amount of inconvenience and suffering inflicted on horses and through the sacrifice of a moderate number of guinea pigs. Who are the merciful people—the few physicians who superintend the making of the antitoxin and make sure of its quality, or the people who cry out against the infliction of any suffering on animals on behalf of mankind?

It is, of course, possible to legislate against an improper use of vivisection. For instance, it should not be allowed in secondary schools or before college classes for purposes of demonstration only; but any attempt to interfere with the necessary processes of medical investigation is, in my judgment, in the highest degree inexpedient, and is fundamentally inhuman.

Yours very truly,

C. W. ELIOT.

HON. JAMES MCMILLAN.

A NATIONAL REPOSITORY FOR SCIENCE AND ART.

A LECTURE was delivered at the Society of Arts on May 18th by Professor Flinders Petrie on 'A National Repository for Science and Art.' Professor Petrie, as reported in the London *Times*, said that the preservation of material for study had become an urgent question. Many of the sciences rested on proofs and bases which were partly or entirely vanishing. Looking at our present needs, and first of all those which he knew of personally, he asked where was the possibility of preserving all the new world of prehistoric man that had opened before us in the last 30 years. There was scarcely a single burial preserved intact in any museum, though they might see long rows of objects from such tombs, divorced from all else that belonged to them. We had nothing yet but stray examples of the prehistoric ages of other countries. In Egypt alone the prehistoric pottery extends to 900 varieties; when he made an offer to the British Museum he was asked to send as few as possible. To get ten square yards more in English museums was a problem. The bulk of the Greek and Latin inscriptions that we possessed was stored in cellars of the British Museum in the worst of lights. When the earliest Greek tools were offered to the British Museum they were declined as being too ugly; and they were lost beyond recall. The subject of casts was a national scandal. As to the last 1500 years the prospect was far worse. Of our own architecture there was no collection, except a small one belonging to the Institute of British Architects. There was no home for any remains of the innumerable buildings that were wiped away by modern changes. Every year the tribes of our Empire were dwindling, becoming extinct, or merging with their rulers. Our civilization had wiped out races at a greater rate in this century than in any other of the world's history. Yet there was no place where the remains of these peoples and of their civilizations could be preserved. The study of variations were only just beginning, and was the key to the great question of species. Yet series of hundreds or thousands of the same objects, however needful, however irreplaceable, could not be kept in existing museums. The larger geological specimens were scarcely ever preserved. Most of the remains of man were irreplaceable, and to suppose that the remains of all the past civilizations of the whole world were to be compressed into one square furlong at Bloomsbury was manifestly absurd. At the beginning of the century the British Museum was begun in an airy suburb. At the end it was in the midst of square miles of houses, with land of high value around it. It is hopeless to suppose that such a site could be fit for the expansion of historical material. To say that nothing should be preserved that was not worth many pounds for each square foot was to destroy all hopes of progress. Yet we virtually did so by saying "The price of preservation is £5 or £10 per square foot; perish all that is not worth so much." Two very different classes of buildings and of conservation were, in the lecturer's opinion, required. For valuable objects of which no possible deterioration must be permitted, and which must be safeguarded from risks of theft, such buildings as our present museums were admirable. But for rougher objects and things of small individual value a much less costly and elaborate system was needed. A fine site in a city, a noble building, costly glass cases were quite inappropriate to the greater part of the material which was to be kept and studied. The system to which the necessities pointed was that of long galleries, far apart, against which much larger annexes could be attached at any point. This might be called the gridiron pattern, and the building must, of course, be placed outside of London rents. Some said: "Let us leave everything to local care; let local museums keep everything as found." They might as well leave things safely buried instead. The local museum had its own uses for elementary instruction, but no student could possibly race over the whole world to find the examples of any subject he needed. Professor Petrie suggested that a square mile of ground should be obtained somewhere within an hour's train from London at a comparatively cheap rate. It would, in a generation or so, be to Greater London what South Kensington was to the Lesser London 50 years ago. This village that would grow up around it might very appropriately be called, after the founder of the British Museum, the village of Sloane. The Sloane Galleries would soon outgrow any confusion with the little collection of Sir John Sloane in Lincoln's-inn-fields. The lecturer worked out in considerable detail the form of the galleries, the cost, the arrangements for the staff, and the fittings, and said that at first the Sloane would be the clearing ground for freeing the existing museums from everything of small value and attractiveness. That the British Museum should thus devolve the care of its contents of lesser value was a necessity that was to be met in the library by powers of very free-handed disposal to locate centers, or even destruction. Such powers in other departments were therefore to be expected sooner or later. As yet nothing could legally leave the museum, but useless lumber could be interred in the grounds. The normal average increase of the vote for the British Museum was £10,000 every four years of its history. If the proposed national repository enabled the British Museum to expand by weeding out, instead of by fresh building, the former would be paid for to all time. All that was absolutely required could be provided on the present system of expenditure if the British Museum were to be weeded during eight years of its more cumbrous and less valuable contents sufficiently to take in its new acquisitions.

SCIENTIFIC NOTES AND NEWS.

Dr. J. Willard Gibbs, professor of mathematical physics in Yale University, has been elected a corresponding member of the Paris Academy of Sciences.

The gold medal of the Linnean Society of London has been awarded to Professor Alfred Newton, F.R.S., in recognition of his important contributions to zoological science. The medal is awarded annually, alternately to a zoologist and to a botanist.

On May 8th the Prince of Wales, president of the Society of Arts, presented the Albert medal to William Crookes, F.R.S., "for his extensive and laborious researches in chemistry and in physics; researches which have, in many instances, developed into useful practical applications in the arts and manufactures."

The Boston Society of Natural History has awarded the first Walker prize of $100 to Dr. Rudolph Ruedemann, assistant N. Y. State paleontologist, the subject of whose essay is the 'Hudson River formation of the vicinity of Albany, N. Y., and its taxonomic equivalents.' The paper will be published as a bulletin of the N. Y. State Museum.

At the meeting of the Paris Académie de Médecine on May 1st, Professors Behring (of Marburg), Golgi (of Pavia), Tilanus (of Amsterdam), and Pawloff (of St. Petersburg), were elected Foreign Associates.

Professors W. Pfeffer of Leipzig, von Richthofen of Berlin, and S. Schwendener also of Berlin, have been elected members of the Academy of Sciences of Christiania.

The following candidates have been selected by the Royal Society for election into the Society: George James Burch, lecturer at University College Reading; T. W. Edgeworth David, professor of geology in the University of Sydney; John Bretland Farmer, professor of botany, Royal College of Science, London; Leonard Hill, lecturer on physiology, London Hospital Medical College; John Home, senior geologist of the Geological Survey of Scotland; Joseph Jackson Lister, demonstrator of comparative anatomy in the University of Cambridge; James Gordon MacGregor, professor of physics, Dalhousie College, Halifax, N. S.; Patrick Manson, physician and medical adviser to the Colonial Office; Thomas Muir, superintendent-general of education in Cape Colony; Arthur Alcock Rambaut, Radcliffe Observer, late astronomer royal of Ireland; William James Sell, senior demonstrator of chemistry, University of Cambridge; W. Baldwin Spencer, professor of biology in the Melbourne University, and James Walker, professor of chemistry, University College, Dundee.

THE Craggs Research Scholarship of £300 a year has been awarded to Dr. G. L. Low, M.A., M.B., C.M., of the London School of Tropical Medicine.

M. CORNU and M. Darboux Jean have been nominated as candidates for election to the permanent secretaryship of the Paris Academy of Sciences.

AN informal reception will be given to Dr. H. S. Pritchett, president-elect of the Massachusetts Institute of Technology, by the Technology Club, on June 5th.

MR. OTTO H. TITTMANN, assistant superintendent of the Coast and Geodetic Survey, will go to Alaska, where he will trace the boundary line established by the *modus vivendi* of October, 1899, between the British government and the United States. He will be absent for about two months.

PRESIDENT GILMAN and Professor Paul Haupt will represent the Johns Hopkins University at the celebration connected with the 500th anniversary of the University of Cracow on June 7th. Cambridge University will be represented by Dr. Alexander Hill and Mr. C. H. Monroe.

PROFESSOR HARRIS, of the department of geology, Cornell University, will take a class with the steam launch the *Orthoceras* to Lake Champlain for geological work.

DR. ALBERT B. PRESCOTT, dean of the pharmaceutical department of the University of Michigan, was elected president of the American Conference of Pharmaceutical Faculties at its first meeting held in Washington, May 11th.

SIGNOR MARCONI left Southampton for New York on May 26th. It is said that he will conduct extensive experiments on wireless telegraphy in this country.

JONAS GILMAN CLARK, the founder of Clark University at Worcester, Mass., died on May 23d, at the age of eighty-five years. Mr. Clark had no children and it is hoped that by his will Clark University will be adequately endowed.

GARDINER S. WILLIAMS, emeritus professor of the science and art of teaching at Cornell University, died on May 19th, at the age of seventy-two years.

THE death is announced of Dr. Edmund Atkinson, at the age of sixty-nine years. He was associated, as assistant to the late Sir Edward Frankland, with the early days of the chemical laboratory of Owens College, Manchester. Afterwards he was for many years professor of experimental science at the Royal Military College, Sandhurst, and at the Staff College.

DR. A. CLAUS, who recently resigned, on account of ill health, from the chair of chemistry, in the University of Freiburg i.B., died on May 7th, aged 60 years.

WE must also record the death at Ealing, England, of Brigade-Surgeon-Lieutenant-Colonel William Center. Lieut. Colonel Center joined the Indian Medical Department in 1865, and from 1871 served in the Punjaub as chemical examiner and professor in the Lahore Medical School. In 1882 he was statistical officer in the sanitary department of the Government of India, and afterwards received the appointment of civil surgeon, Lahore, and superintendent of the lunatic asylum. From 1888 until his retirement in 1893 he held one of the chairs at Lahore Medical College.

THE Croonian lectures before the Royal College of Physicians of London, will be delivered on June 19th, 21st, 26th and 28th, by Dr. F. W. Mott, F.R.S., pathologist to the London County Asylums, who has taken for his subject 'The Degeneration of the Neuron.'

A FIRE occurred in the Astronomical Observatory of Yale University on May 22d. Damage to the extent of about $500 was caused, and at one time the entire observatory was in danger. The fire was caused by a defective gas jet in the photographic room.

SEVERAL positions of a partly scientific character will be filled by a competitive examination in the State of New York on June 2d. These include an assistant commissioner of agriculture and a bridge designer in the office of the State Engineer and Surveyor.

As we have already announced, the University of Illinois has fallen heir to the Bolter Collection of Insects. The collection numbers approximately fifteen thousand species, represented by about seventy thousand specimens, besides thirty thousand duplicates not in the systematic collection. This collection, accumulated during the last fifty years by the late Andreas Bolter, a business man of Chicago, is remarkable for the excellence of the material and for the exquisite care with which it has been prepared and arranged. It represents all orders of insects and North America in general, and contains also a considerable amount of exotic material. The gift was made by the executors of Mr. Bolter, in accordance with the terms of his will, conditional upon its maintenance as a unit, under the name of the 'Bolter Collection of Insects,' in a fire-proof building.

THE valuable series of specimens collected by Mr. R. T. Günther in N. W. Persia, and described by him and others in the *Journal of the Linnean Society* (London) published last January is now incorporated with the collections of the British Museum.

A COMMITTEE of the Society for Plant Morphology and Physiology consisting of Professor Farlow, Dr. MacDougal, and Dr. Von Schrenk, will report to a business meeting of that body in New York in the last week in June upon the feasibility of securing an improved method of bibliographical reviews in botany.

THE Right Hon. W. H. Long, M.P., President of the British Board of Agriculture, has appointed a Departmental Committee to inquire into the conditions under which agricultural seeds are at present sold, and to report whether any further measures can with advantage be taken to secure the maintenance of adequate standards of purity and germinating power. The Committee will consist of the following members, viz: The Earl of Onslow, G.C.M.G., chairman; Sir W. T. Thiselton-Dyer, K.C.M.G., C.I.E.; Sir Jacob Wilson; Mr. R. A. Anderson, Secretary of the Irish Agricultural Organization Society; Mr. R. Stratton, The Duffryn, Newport (Mon.); Mr. Martin J. Sutton, Henley-park, Oxon.; Mr. James Watt, Knowefield, Carlisle, and Mr. David Wilson, Carbeth, Killearn, N. B. Mr. A. E. Brooke-Hunt of the Board of Agriculture, will act as secretary to the committee.

THE *Fourth Annual Report* of the New York Zoological Society contains besides reports of the Executive Committee, Director and Treasurer, a list of members, and the various acts relating to the Park, as well as a number of plates illustrating details of construction and installation and positions of the herds of elk and bison. The Society is to be congratulated upon the rapid progress it has made since assuming control of the grounds in August, 1898, and also upon the fact that every dollar has been expended to good advantage. It is to be hoped that it may succeed in increasing its membership and in securing the funds needed for the proper maintenance of the park. The number of animals in the park on Jan. 1, 1900, was 781, distributed as follows: mammals, 44 species, 151 individuals; birds, 43 species, 185 specimens; reptiles, 92 species, 445 specimens.

THE authorities of the British Museum have decided to adopt a system of hydraulic pressure upon all the fire mains of the institution as an additional precaution against fire. By the adoption of this system a pressure of water of enormous force will be obtained by the mere turning of a couple of wheels, and the necessity for the fire engines which are at present on the roof of the museum will be obviated.

THE new British National Physical Laboratory will not be erected on grounds belonging to Kew Gardens as has been stated but on crown land outside the Gardens.

THE coming meeting of the American Association will offer several special features to the botanists. Among these we note that Section G. will be the guests of the New York Botanical Garden on Wednesday, June 27th, on which date the Torrey memorial program will be given in the lecture hall of the museum of the Garden. The special features of this program have been noted in a previous number of this JOURNAL. The Section and the Botanical Society of America will hold a joint session on Thursday, June 28th, in which the program of the latter including the president's address will be given. A general discussion of the plant geography of North America has been arranged for Friday, June 29th, in which Dr. F. V. Coville, Dr. John Macoun, Professor B. L. Robinson, Dr. John K. Small, Professor W. A. Kellermann, Dr. Roscoe Pound, Dr. H. C. Cowles, Dr. P. A. Rydberg, Dr. J. N. Rose, Professor C. V. Piper, Professor W. L. Bray, Mr. T. H. Kearney, Dr. N. L. Britton and perhaps one or two foreign botanists will participate. The last general presentation of this subject in a systematic manner was given at the Indianapolis meeting in 1890, since which time such advances have been made in the development of the principles that govern plant distribution, and in the collation of facts from the careful study of the flora that the coming symposium is bound to be of great interest and lasting value.

UNDER the auspices of the Boston Society of Natural History, a series of courses in natural history, including geology, zoology and botany, will be given at Bayville, Linekin Bay, Maine, beginning Friday, July 6, 1900, and continuing for three weeks. The object of these courses is to teach the elements of natural history by observation in the field and laboratory under trained instructors, and to furnish opportunity for more extended work in one or more of the branches taught, to those who desire it, under the guidance of the instructors. Mr. A. W. Grabau, of Rensselaer Polytechnic Institute, will give instruction in zoology; Mr. Freeland Howe, Jr., of Harvard University, in zoology, and Mr. C. E. Preston, assistant in Harvard University, in botany. Further particulars may be obtained by addressing Mr. A. W. Grabau, Boston Society of Natural History, Boston, Mass.

THE New Mexico Biological Station, conducted by Professor T. D. A. Cockerell and Miss Wilmatte Porter, will be in session at Las Vegas during June and July. Special attention will be given to the local plants and insects.

A FEW years ago it was necessary to import from abroad most of the scientific apparatus required for instruction and research. At present such apparatus is to a large extent made at home, and there are indications that it will soon be exported to a considerable degree. Thus Messrs. Queen & Co., of Philadelphia, have recently received an order from a foreign government for two Ruhmkorff induction coils which will be the largest ever made. The celebrated Spottiswoode coil, built under the auspices of the Royal Society, gave a spark of 42 inches. The Queen coils are to give a spark of 45 inches, expending an energy of 3 to 4 horsepower, and having a potential of half a million volts.

AT a meeting of the Zoological Society of London on May 8th, Mr. J. S. Budgett, F.Z.S., read a paper entitled 'Some Points in the Anatomy of *Polypterus*,' as deduced from an examination of specimens lately procured by the author in the River Gambia. The urinogenital organs of the male and female *Polypterus* were described in detail; those of the male, it was believed, for the first time, while the description now given of the genital ducts in the female did not entirely agree with those of previous writers. The later stages in the formation of these organs were also described, and it was shown that the condition found in the Ganoid *Lepidosteus*, where the products of the testis are carried away by the tubules of the kidney, was not primitive. Some new points of interest in the vascular system were communicated, and reasons were given for not regarding the external gill of *Polypterus* as homologous with the hyoidean pseudobranch of *Acipenser*, but rather with the external gill of the Dipnoi and the Amphibia. The formation of the abdominal pores of *Polypterus* was also described, and the use of the enlarged anal fin of the male in the breeding-season was discussed.

UNIVERSITY AND EDUCATIONAL NEWS.

THE wills of John Nicholas Brown and Harold Brown were filed in Newport on May 22d. Brown University receives $25,000 from them each. J. N. Brown leaves $150,000 for a library building and $500,000 for an endowment, the place of the library to be selected by the trustees. Both wills contain a number of charitable bequests.

WASHINGTON AND LEE UNIVERSITY receives $3000 for a scholarship by the will of the late Mrs. Juliet S. Bradford.

THE entomological collection belonging to the late Dr. J. A. Lintner, for many years State entomologist, is to be given to Cornell University by his widow as a memorial to her husband.

MR. THOMAS ANDREWS, F.R.S., has given to the Chemical Laboratory of Cambridge University one of the Echelon spectroscopes, invented by Professor A. A. Michelson.

A DORMITORY is being erected by Cornell University on the tract of land in the Adirondacks, used in connection with the School of Forestry.

IT is said that a commercial university will soon be established at Hamburg with all the rights of the German universities and technical schools. Provision will be made for chairs in all scientific subjects connected with commerce.

ON May 9th, the Convocation of Oxford University established the new degrees of Doctor in Science and in Literature. Now it will no longer be necessary for graduates in science of this ancient seat of learning to take the examinations of London University for the sake of obtaining a doctorate. Thus the impulse given to research will be both direct and indirect.

MR. BALFOUR has consented to give the inaugural address at the summer meeting for University Extension students and others to be held at Cambridge in August. The meeting will last from August 2d to 27th, and during that time over one hundred lectures will be delivered upon different aspects of life and thought in England in the nineteenth century. Amongst those who will lecture are Professor Jebb, M.P., Professor A. V. Dicey, Professor Clifford Allbutt, Dr. Augustus Jessopp, the Master of Trinity, Sir Robert Ball, Professor J. J. Thomson, the Bishop of Southampton, Sir Joshua Fitch, and the Dean of Ely.

A REQUISITION addressed to Lord Balfour is being signed, asking him to allow himself to be nominated for the chancellorship of St. Andrews University, vacant by the death of the Duke of Argyll. The appointment rests with the general council of the University, and is held by the occupant for life.

MR. LAURENCE EDMONDS GRIFFIN, Bruce Fellow and candidate for the degree of Doctor of Philosophy this year at the Johns Hopkins University, has been appointed instructor in biology in the College for Women of the Western Reserve University, in the place of the late Dr. N. R. Harrington.

ALICE W. WILCOX, instructor in biology at Vassar College, has been appointed by the faculty to hold the Babbott Fellowship for 1900 1901 and will do graduate work in biology at the University of Chicago.

SEVERAL changes have recently taken place in the medical staff of University College, London. Dr. Sydney Ringer has retired from the Holme professorship of Clinical Medicine, and has been succeeded by Dr. F. T. Roberts. Mr. Christopher Heath has resigned the Holme professorship of Clinical Surgery and is succeeded by Mr. Rickman J. Godlee. Dr. Roberts on taking up the Holmes professorship has resigned the professorship of the principles and practice of medicine, and the council have selected Dr. G. Vivian Poore to succeed him.

DR. JOHN WYLLIE has been elected professor of medicine in the University of Edinburgh in succession to the late Sir Thomas Grainger Stewart.

SCIENCE

Friday, June 8, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*VARIATION AND SOME PHENOMENA CONNECTED WITH REPRODUCTION AND SEX.**

I.

In the following address an attempt is made to treat the facts of variation and heredity without any theoretical preconceptions. The ground covered has already been made familiar to us by the writings of Darwin, Spencer, Galton, Weismann, Romanes, and others. I have not thought it advisable to discuss the theories of my predecessors, not from a want of appreciation of their value, but because I was anxious to look at the facts themselves and to submit them to an examination which should be as free as possible from all theoretical bias.

Zoology is the science which deals with animals. Knowledge regarding animals is, for convenience of study, classified into several main branches, amongst the most important of which may be mentioned; (1) the study of structure; (2) the study of the functions of the parts or organs; (3) the arrangement of animals in a system of classification; (4) the past history of animals; (5) the relations of animals to their environment; (6) the distribution of animals on the earth's surface. That part of the Science of Zoology which deals

* Address of the president to the Zoological Section of the British Association for the Advancement of Science, Dover, 1899.

with the functions of organs, particularly of the organs of the higher animals, is frequently spoken of as Physiology, and separated more or less sharply from the rest of Zoology under that heading. So strong is the line of cleavage between the work of the Physiologist and that of other Zoologists, that this Association has thought it advisable to establish a special Section for the discussion of physiological subjects, leaving the rest of Zoology to the consideration of the old-established Section, D. In calling attention to this fact, I do not for one moment wish to question the advisability of the course of action which the Association has taken. The Science of Physiology in its modern aspects includes a vast body of facts of great importance and great interest which no doubt require separate treatment. But what I do wish to point out is that it is quite impossible for us here to abrogate all our functions as physiologists. Some of the most important problems of the physiological side of Zoology still remain within the purview of this Section.

For instance, the important and far-reaching problems connected with reproduction and variation are very largely left to this Section, and that large group of intricate and almost entirely physiological phenomena connected with the adaptations of organisms to their environment are dealt with almost exclusively here. Indeed, we may go further, and say that apart altogether from practical questions of convenience, which make it desirable to separate a part of physiological work from the Zoological Section, it is, as a matter of fact, impossible to divorce the intelligent study of structure from that of function. The two are indissolubly connected together. The differentiation of structure involves the differentiation of function, and the differentiation of function that of structure. The conceptions of structure and function are as closely associated as those of matter and force. A zoologist who confined himself to the study of the structure of organisms, and paid no attention to the functions of the parts, would be as absurd a person as a philologist who studied the structure of words and took no account of their meaning. In the early part of this century, when the subject matter of zoology was not so vast as it is at present, this aspect of the case was fully recognized, and one of the greatest zoologists of the century, whether considered from the point of view of modern anatomy, or of modern physiology, was Professor of Anatomy and Physiology at the University of Berlin.

Having said that much as to the various aspects of living Nature, of natural history, if you like, which it falls within the province of this Section to deal with, I may now proceed to the subject of my address. And when I mention to you what that subject is, you will be able to make some allowance for the somewhat commonplace remarks with which I have treated you. For that subject, though it has its important morphological aspects, is in the main a physiological one; at any rate, no study which does not take account of the physiological aspect of it can ever hope to satisfy the intellect of man.

The subject, then, to which I wish to draw your attention at the outset of our proceedings, is the great subject of Variation of Organisms.

As everyone knows, there is a vast number of different kinds of organisms. Each kind constitutes a species, and consists of an assemblage of individuals which resemble one another more closely than they do other animals, which transmit their characteristics in reproduction and which habitually live and breed together. But the members of a species, though resembling one another more closely than they resemble the members of other species, are not absolutely alike. They present differences, differences which make themselves apparent even in members of the same family, *i. e.*, in the offspring of the same parents. It is these differences to which we apply the term *variation*. The immense importance of the study of variations may be judged from the fact that, according to the generally received evolution theory of Darwin, it is to them that the whole of the variety of living and extinct organisms is due. Without variation there could have been no progress, no evolution in the structure of organisms. If offspring had always exactly resembled their parents and presented no points of difference, each succeeding generation would have resembled those previously existing, and no change, whether backwards or forwards, could have occurred. This phenomenon of genetic variation forms the bedrock upon which all theories of evolution must rest, and it is only by a study of variations, of their nature and cause, that we can ever hope to obtain any real insight into the actual way in which evolution has taken place. Notwithstaading its importance, the subject is one which has scarcely received from zoologists the attention which it merits.

Though much has been written on the causes of variation, too little attention has of late years been paid to the phenomenon. Since the publication of Darwin's great work on the 'Variation of Animals and Plants under Domestication,' there have been but few books of first-rate importance dealing with the subject. The most important of these is Mr. William Bateson's work, entitled 'Materials for the Study of Variation.' I have no hesitation in saying that I regard this work as a most important contribution to the literature of the Evolution theory. In it attention is called, with that emphasis which the subject demands, to the supreme importance of the actual study of variation to the evolutionist, and a systematic attempt is made to classify variations as they occur in Nature. In preparing this book Mr. Bateson has performed a very real service to zoology, not the least part of which is that he has made a most effective protest against that looseness of speculative reasoning which, since the publication of the 'Origin of Species,' has marred the pages of so many zoological writers.

The Variations of Organisms may be grouped under two heads, according to their nature and source: (1) There are those variations which appear to have no relation to the external conditions, for they take place when these remain unchanged, *e. g.*, in members of the same litter; they are inherent in the constitution of the individual. These we shall call constitutional variations, or as their appearance seems nearly always to be connected with reproduction, they may be called *genetic* (congenital, blastogenic) *variations*. (2) The second kind of variations are those which are caused by the direct action of external conditions. These variations constitute the so-called *acquired characters*.

My first object is to consider these two kinds of variations, their nature, their causes and their results on subsequent generations and to inquire whether there are any fundamental differences between them. In this connection it is of particular importance that we should inquire whether acquired modifications are transmitted in reproduction. As is well known, there are two schools of thought holding directly opposite views as to this matter. The one of these schools—the so-called Lamarckian school—holds that they may be transmitted as such in reproduction; the other school, on the other hand, maintains that acquired modifications affect only the individual concerned, and are not handed on as such in reproduction. That the decision of the matter is not only theoretically important, but also practically, is evident, for upon it depends the answer to the question whether mental or other facilities acquired by the laborious exercise of the individual are ever transmitted to the offspring—whether the facility which the individual acquires in resisting temptation makes it any easier for the offspring to do the same, whether the effects of education are cumulative in successive generations. To put the matter as Francis Galton has put it, is nature stronger than nurture, or nurture than nature?

We have then two kinds of variation to consider: (1) genetic variation, (2) acquired modification. It is the former of these—namely, genetic variation—with which I wish primarily to deal. Let us examine more fully the mode of its occurrence.

GENETIC VARIATION.

Organized beings present, as you are aware, two main kinds of reproduction, the sexual and the asexual. These two kinds of reproduction present certain differences, of which the most important, and the only one which concerns us now, is the fact that genetic variation is essentially associated with sexual reproduction, and is rarely, if ever, found in asexual reproduction. In other words, whereas the offspring resulting from asexual reproduction as a rule exactly resemble the parent, they are always different from the parents in sexual reproduction. I am aware that I am treading on disputed ground. You will observe that I do not make the assertion that asexually produced offspring *always* exactly resemble the parent, and never present genetic variations. To say that would be going too far in the present state of our knowledge. Therefore I have put the matter less strongly, and merely assert that whereas asexual reproduction is on the whole characterized by identity between the offspring and the parent, sexual reproduction is always characterized by differences more or less marked between the two; and I reserve the question as to whether genetic variations are ever found in asexual reproduction for later consideration.

This modified form of the statement will, I think, be admitted on all hands, but before going on I will illustrate my meaning by reference to actual examples.

Asexual reproduction is a phenomenon comparatively rare in the animal kingdom, and when it does occur it is exceedingly difficult to investigate from this particular point of view. In the vegetable kingdom, on the other hand, it is quite common. All, or almost all, plants possess this power, and in a very great many of them the result of its exercise can be fully followed out, and contrasted with that of sexual reproduction. Let us follow it out in the potato-plant. The potato can and does normally propagate itself asexually by means of its underground tubers. As you will know, if you take one of these and plant it, it gives rise to a plant exactly resembling the parent. If the tuber (seed as it is sometimes erroneously called) be that of the Magnum Bonum, it gives rise to a plant with foliage, flowers and tubers of the Magnum Bonum variety; if it be the Snowdrop, the foliage, flowers, habit and tubers are totally different from the Magnum Bonum, and are easily identified as Snowdrops. In this way a favorable variety of potato can be reproduced to almost any extent with all its peculiarities of earliness or lateness, pastiness or mealiness, power of resisting disease and so forth. By asexual reproduction the exact fac-simile of the parent may always be obtained, provided the conditions remain the same.

Now let us turn to the results of sexual reproduction—the seeds, *i. e.*, the real seeds, which as you know are produced in the flowers, are the means by which sexual reproduction is effected. They are produced in great quantity by most plants, and when placed in the ground under the proper conditions they germinate and produce plants. But these plants do not resemble the parent. Try the seed of the Magnum Bonum potato and raise plants from it. Do you think that any of them will be the Magnum Bonum with all its properties of keeping, resisting disease and so forth? Not a bit of it. The probability is, that not one of your seedling plants will exactly reproduce the parents; they will all be different. Again, take the apple; if you sow the seed of a Blenheim Orange and raise young apple-trees, you will not get a Blenheim Orange. All your plants will be different, and probably not one will give you apples with the peculiar excellence of the parent. If you want to propagate your Blenheim Orange and increase the number of your trees, you must proceed by grafting or by striking cuttings, which are the methods by which such a tree may be asexually reproduced. And so on. Examples might be multiplied indefinitely. Every horticulturist knows that variety characterizes seedlings, *i. e.*, sexual offspring, whereas identity is found in slips, grafts and offsets, *i. e.*, in asexual offspring; and that if you want to get a new plant you must sow seeds, while if you want to increase your stock of an old one you must strike cuttings, plant tubers or proceed in some analogous manner.

An apparent exception to this rule is afforded by so-called bud variation, but it is not certain that this is really an exception. In so far as these bud variations are not of the nature of acquired variations produced by a change of external conditions, and disappearing as soon as the old conditions are renewed, they are probably stages in the growth and development of the organism. That is to say, they are of the same nature as those peculiarities in animals which appear at a particular time of life, such as a single lock of hair of a different color from the rest of the hair,* the change in color of hair with growth,† the appearance of insanity or of epilepsy at a particular age. There is nothing more remarkable in a single bud on a tree departing from the usual character at a particular time of life, than in a particular hair of a mammal doing the same thing.

*Darwin, *Variation*, Vol. I., p. 449.

† As an example I may refer to the Himalayan rabbit; Darwin, *Variation*, Vol. I., p. 114.

We have seen that, speaking broadly, genetic variation is connected with sexual reproduction, and it becomes necessary to examine this mode of reproduction a little more fully. What is the essence of sexual reproduction, and how does it differ from asexual? What I am now going to say applies generally to the phenomenon whether it occurs in plants or animals. Sexual reproduction is generally carried on by the co-operation of two distinct individuals—these are called the male and female respectively. They produce, by a process of unequal fission which takes place at a part of their body, called the reproductive gland, a small living organism called the reproductive cell. The reproductive cell produced by the male is called in animals the spermatazoon, and is different in form from the corresponding cell produced by the female, and called in animals the ovum. The object with which these two organisms are produced is to fuse with one another and give rise to one resultant uninucleated organism or cell, which we may call the *zygote*. This process of fusion between the two kinds of reproductive cells, which are termed *gametes*, is called conjugation. The difference in structure between the male and female gamete is a matter of secondary importance only, and is connected with the primary function of coming into contact and fusing. The same may be said with regard to the so-called sexual differences of the parents of the two kinds of gametes, and to the powerful instincts which regulate their action. The conjugation of the male and female gamete, or the fertilization of the ovum, as it is sometimes called, consists in the fusion of two distinct masses of protoplasm which are nearly always produced by different individuals. In the case of hermaphrodites, the term applied to organisms which produce both male and female gametes in the same individual, there is generally some arrangement which tends to prevent the male gamete from conjugating with the female gamete of the same parent; but this phenomenon is not absolutely excluded, and takes place as a normal phenomenon in many plants and possibly in some animals.

This fusion of the protoplasm of the two gametes gives us a uninucleated organism —for the fusion of the nuclei of the two gametes seems to be an essential part of the process—in which the potencies of the two gametes are blended. The *zygote*, as the mass formed of the fused gametes is called, is formed by the combination of two individualities, and is therefore essentially a new individuality, the characters of which will be different from the characters of both of the parents. This fact, which is not apparent in the zygote when first established, because the parts are hardly distinguishable by our senses, becomes obvious as soon as organs, with the appearance of which we are familiar, are formed. As a general rule this cannot be said to have occurred until what we call maturity has been nearly reached, because we are not familiar enough with the features of immature organisms to detect individual differences. But you may rest assured that such differences exist at all stages of growth from that of the uninucleated zygote till death. How the characters of the two parents will combine in the zygote it is impossible to predict, and the result is never the same even though the conjugations have been between gametes of identical origin. There may be an almost perfect mixture, the blending extending to even quite minute details; or the characters of the one parent may predominate—be prepotent, as we call it—over those of the other; or they may blend in such a way that the zygote offers characters found in neither parent. Or, finally, the features of one parent may come out at one stage of growth, those of the other at another stage. But, however the characters may blend, the product never exactly resembles the parents. The extent to which it differs from them is the measure of the variation.

To resume, it will be observed that in the method of reproduction sometimes called sexual, two distinct processes occur. One of these is the real reproductive act, which consists in the production by fission of uninuclear individuals called gametes; the second is the fusion of the gametes to form the zygote. The gametes are of two kinds, and the reason of there being two kinds is intelligible when we consider the parts they have to play. The male gamete is nearly always endowed with locomotive power, and the female gamete is stored with food material to be used by the zygote in the first stages of growth. The destiny of these two uninucleated organisms is to fuse with one another, and so to give rise to a zygote which ultimately assumes the typical form of the species. As a general rule the gametes have but a limited duration* of life unless they conjugate, and this is quite intelligible when we remember that they have no organs, *e. g.*, digestive organs, suitable for the maintenance of life. It is rarely found that they have the power of assuming the form of their parent, unless they conjugate. This never happens in the case of the male gamete (at any rate in animals), and only rarely in that of the female. When it occurs—that is to say, when the ovum develops without conjugation—we call the phenomenon parthenogenesis. Parthenogenesis is found more

*Under favorable conditions they may live a considerable time—*e. g.*, the spermatozoon of certain ants, which are stated by Sir John Lubbock to live in some cases for seven years.

commonly in Arthropods than in other groups, but it may be more common than is supposed.*

In sexual reproduction then, in addition to the real reproductive act, which is the division by fission of the parent into two unequal parts, the one of which continues to be called the parent, while the other is the gamete, there is the subsequent conjugation process. It is to this conjugation process that that important concomitant of sexual reproduction must be attributed, namely genetic variation. We have thus traced genetic variation to its lair. We have seen that it is due to the formation of a new individuality by the fusion of two distinct individualities. We have also seen that in the higher animals it is always associated with the reproductive act.

Let us now take a wider survey and endeavor to ascertain whether this most important process, a process upon which depends the improvement as well as the degradation of races, ever takes place independently of the reproductive act. In the Metazoa, to which for our present purpose I allude under the term higher animals, conjugation never takes place except in connection with reproduction. It is impossible from the nature of the process that it should do so, as I hope to explain later on. But among the Protozoa, the simplest of all animals, it is conceivable that conjugation might take place apart from reproduction, and as a matter of fact it does do so. Let us now examine a case in which this occurs. Amongst the free-swimming ciliated Infusoria it frequently happens that two individuals become applied together, and that the protoplasm of their bodies becomes continuous. They remain in this condition of fusion for some days, retaining however their external form and not undergoing complete fusion. While the continuity lasts there is an exchange of living substance between the two bodies, in which exchange a bit of the nucleus of each participates. It thus happens that at the end of conjugation, when the two animals separate, they are both different from what they were at the commencement; each has received protoplasm and a nucleus from its fellow, and the introduced nucleus fuses, as we know, with the nucleus which has not moved. It would therefore appear that all the essential features of the conjugation process, as we learned them in the case of the conjugation of the gametes in the Metazoa are present, and it is impossible to doubt that we have here an essentially similar phenomenon. The phenomenon differs, however, from the conjugation first described in this interesting and important respect, that the two animals separate and resume their ordinary life. It is true that their constitution must have been profoundly changed, but they retain their general form. I say that the constitution of the exconjugates, as we may call them after they are separated, must be different from what it was before conjugation, but so far as I know no difference in structure corresponding with this difference in constitution has been recorded. I feel no sort of doubt, however, that structural differences, *i. e.*, variations, will be detected when the exconjugates are closely scrutinized and compared with the animals before conjugation, and I would suggest that definite observations be made with a view to testing the point. Here, then, we have a case of conjugation entirely dissociated from reproduction. Other cases of a similar character are known among the Protozoa, though as a general rule the fusion between the conjugating organisms is complete and permanent. Among plants, conjugation is generally associated with repro-

*It may be mentioned as a curious fact that parthenogenesis is rarely found in the higher plants, and, as I have said, is not known for the male gamete among animals.

duction, but not always, for in certain fungi* fusion of hyphæ and consequent intermingling of protoplasm occurs, and is not followed by any form of reproduction. Among bacteria alone, so far as I know, has the phenomenon of conjugation never been observed.

To sum up, we have seen that the phenomenon of conjugation is very widely distributed. Excluding the bacteria, there is reason to believe that it forms a part of the vital phenomena of all organisms. Its essential features are a mixture and fusion of the protoplasm of two different organisms, accompanied by a fusion of their nuclei. It results in the formation of a new individuality, which differs from the individualities of both the conjugating organisms. This difference manifests itself in differences in habit, constitution, form and structure; such differences constituting what we have called genetic variations.

The conjugation of the ovum and spermatozoon in the higher animals, and the corresponding process in the higher plants, are special cases of this conjugation, in which special conjugating individuals are produced, the ordinary individuals being physically incapable of the process. The phenomenon of sex, with all its associated complications, which is so characteristic of the higher animals and plants, is merely a device to ensure the coming together of the two gametes. In the lower animals it is possible for the ordinary organism to conjugate; consequently the phenomenon does not form the precursor of developmental change, and is in no way associated with reproduction. Indeed, in such cases it is often the opposite of reproduction, inasmuch as it brings about a reduction in the number of individuals two separate individuals fusing to form one.

* It must be mentioned, however, that in the case of these fungi the fusion of nuclei has not been observed, nor has it been noticed whether the habit, structure, or constitution of the conjugating plants are altered after the fusion.

ACQUIRED CHARACTERS.

We now come to the consideration of the second kind of variations—namely, those which owe their origin to the direct action of external agencies upon the particular organism which shows the variation; or, as Darwin puts it, to the definite action of external conditions. These are the variations which I have called acquired variations or acquired characters. This is not a good name for them, but at the present moment, when I am about to submit them to a critical examination, I do not know of any other which could be suitably applied. Later on, when I sum up the various effects of the direct action of external agencies upon the organism, I may be able to use a more suitable term.

The main peculiarities of acquired variations are two in number: (*a*) they make their appearance as soon as the organism is submitted to the changed conditions; (*b*) speaking generally they are more or less the same in all the individuals of the species acted upon. As examples of this kind of variations, I may mention the effect of the sun upon the skin of the white man; the Porto Santo rabbit, an individual of which recovered the proper color of its fur in four years under the English climate;* the change of *Artemia salina* to *Artemia milhausenii*; the increase in size of muscles as the result of exercise; and the development of any special facility in the central nervous system. Among plants, variations of this kind are very easily acquired, by altering the soil and climate to which the individuals are submitted. So common are they, that it is quite possible that a large number of species are really based upon characters of this kind; characters which are produced solely by the external conditions and which

* Darwin, *Variation*, ed. 2, Vol. I., p. 119.

frequently disappear when the old conditions are reverted to.

With regard to these variations, we want to ask the following question: Do they ever last after the producing cause of them is removed, and are they transmitted in reproduction? In a great number of cases they either cease when the cause which has produced them is removed, or if they last the life of the individual they are not transmitted in reproduction. But is this always the case? That is the important question we now have to consider.

But before doing so let us inquire what acquired characters really are. The so-called adults of all animals have, as part of their birthright, a certain plasticity in their capacity of reacting to external influences; they all have a certain power of acquiring bodily and mental characters under the influence of appropriate stimuli. This power varies in degree and in quality in different species. In plants, for instance, it is mainly displayed in habit of growth, form of foliage, etc.; in man in mental acquirements, and so on. But however it is displayed, it is this property of organisms which permits of the acquisition of those modifications of structure which have been so widely discussed as *acquired* characters. Now this power, when closely considered, is in reality only a portion of that capacity for development which all organisms possess, and with which they become endowed at the act of conjugation. A newly formed zygote possesses a certain number of hidden properties which are not able to manifest themselves unless it is submitted to certain external stimuli. It is these stimuli which constitute the external conditions of existence, and the properties of the organism which are only displayed under their influence are what we call acquired characters. They are acquired in response to the external stimuli.

It would appear, then, that every feature which successively appears in an organism in the march from the uninucleated zygote to death is an acquired character. At first the stimuli which are necessary are quite simple, being little more than appropriate heat and moisture; later on they become more complicated, until finally, when the developmental period is over and the mature life begins, the necessary conditions attain their greatest complexity, and their fulfilment constitutes what we call in the higher animals education. Education is nothing more than the response of the nearly mature organism to external stimuli, the penultimate response of the zygote to external stimuli, the ultimate being those of senile decay, which end in natural death. Acquired properties, it will be seen, are really stages in the developmental history. They differ in the complexity of the stimulus required to bring them out. For instance, the segmentation of the egg requires little more than heat and moisture, the walking of the chick the stimulus of light and sound and gravity, the evolutions of an acrobat the same in greater complexity, and lastly the action of a statesman requires the stimulation of almost every sense in the greatest complexity. Moreover, not only are there differences in the complexity of the stimulus required, but also in the rapidity with which the organism reacts to it. The chick undergoes its whole embryonic development in three weeks, a man in nine months; the chick develops its walking mechanism in a few minutes, while a man requires twelve months or more to effect the same end. Chickens are much cleverer than human beings in this respect. There is the same kind of difference between them that there is between the power of learning displayed by a Macaulay and that displayed by a stupid child.

An instinct is nothing more than an internal mechanism which is developed with great rapidity in response to an appropriate stimulus. It is difficult for us to understand instincts, because with us almost all developmental processes are extremely slow and gradual. This particularly applies to the development of those nervous mechanisms, the working of which we call reason.

Within certain limits the external conditions may vary without harming the organism, but such variations are generally accompanied by variations in the form in which the properties of the zygote are displayed. If the variations of the conditions are too great, their action upon the organism is injurious, and results in abortions or death. And in no case can the external conditions call out properties with which the zygote was not endowed at the act of conjugation.

It would thus appear that acquired characters are merely phases of development; they are the manifestations of the properties of the zygote, and are called forth only under appropriate stimulation; moreover, they are capable of varying within certain limits, according to the nature of the stimulus, and it is to these variations that the term acquired character has been ordinarily applied.

A genetic character, on the other hand, is the possibility of acquiring a certain feature under the influence of a certain stimulus; it is not the feature itself—that is an acquired character— but it is the possibility of producing the feature. Now as the possibility of producing the feature can only be proved to exist by actually producing it, the term genetic character is frequently applied to the feature itself, which is, as we have seen, an acquired character. In consequence of this fact, that we can only determine genetic characters by examining acquired characters, a certain amount of confusion may easily arise, and has indeed often arisen, in dealing with this subject. This can be avoided by remembering that in describing genetic characters account must always be taken of the conditions. For example, the white fur of the Arctic hare is an acquired character, acquired in response to a certain stimulus; while the power of so responding to the particular stimulus when applied at the correct time is a genetic character. Thus a genetic character is a character which depends upon the nature of the organism, while an acquired character depends on the nature of the stimulus.

If we imagine a zygote to be a machine capable of working out certain results on material supplied to it, then we should properly apply the term genetic character to the features of the machinery itself, and the words acquired character to the results achieved by its working. These clearly will depend primarily on the structure of the machinery, and secondarily upon the material and energy supplied to it—that is to say, upon the way in which it is worked.

Variations in genetic characters are variations in the machinery of different zygotes that is to say, in the constitution—while variations in acquired characters are variations in the results of the working of one zygote according to the conditions under which it is worked.

For instance, let us take the case of those twins which arise by the division of one zygote, and are consequently identical in genetic characters, *i. e.*, in constitution. If they are submitted to different conditions, they will develop differences which will depend entirely upon the conditions and the time of life when the differentiation in the conditions occurred. These differences then will be a function of the external conditions, *i. e.*, of the manner in which the machinery is worked, and constitute what we call variation in acquired characters.

ARE ACQUIRED CHARACTERS TRANSMISSIBLE AS SUCH IN REPRODUCTION?

To return to our question, are the so-called acquired characters ever transmitted in reproduction? Let us consider what this question means in the light of the preceding discussion. Acquired characters are features which arise in the zygote in response to external stimuli. Now the zygote at its first establishment has none of the characters which are subsequently acquired. All it has is the power of acquiring them. Clearly, then, acquired characters are not transmitted. The power of producing them is all that can be transmitted; and this power resides in the reproductive organs and in the gametes to which the reproductive organs give rise, so that the question must be put in another form. Is it possible by submitting an organism to a certain set of conditions, and thus causing it to acquire certain characters, so to modify its reproductive organs that the same characters will appear in its offspring as the result of the application of a different and simpler stimulus?

For instance, the power of reading conferred by education, the hardness of the hands and increased size of the muscles produced by manual labor: is it possible that these characters, now produced by complex external stimuli applied at a particular period of life, should ever in future ages be produced by the simpler stimuli found within the uterus, so that a man may be born able to read or write, or with hands horny and hard like those of a navvy?

In trying to find an answer to this question let us first of all look into the probabilities of the case, to see if we can relate the question to any other class of phenomena about which we have, or think we have, definite knowledge.

When an organism is affected by external agents the action may apply to the whole organization or principally to one organ. Let us take a case in which one organ only appears to be affected, *e. g.*, the enlargement by exercise of the right arm of a man. Now, although in this case it is only the muscles of the arm which appear at first sight to be affected, we must not forget that the organs of the body are correlated with one another, and an alteration of one will produce an alteration in others. By exercise of the right arm the muscles of that arm are obviously enlarged, but other changes not so obvious must also have taken place. The bones to which the muscles are attached will be altered; the blood-vessels supplying the muscles will be enlarged, and the nerves which act upon the muscles, and probably the part of the central nervous system from which they proceed, will also be altered. These are some of the more obvious correlated changes which will have occurred; no doubt there will have been others—indeed it is not perhaps too much to say that all the organs of the body will have reacted to the enlargement of the arm —but the effect on organs not in functional correlation with the muscles of the right arm will be imperceptible, and may be neglected. Thus the color of the hair, the length and character of the alimentary canal, size of the leg muscles, the renal organs, etc., will not show appreciable alteration. Above all, the other arm will not be affected, or if it is affected the alteration will be so slight as not to be noticeable. Now, we know that homologous parts, whether symmetrically homologous or serially so, are in some kind of close connection. For instance, when one member of an homologous series varies, it is commonly found that other members of the same series will also vary. Yet in spite of this connection which exists between the right and left arms and between the right arm and right leg there is no similar alteration either in the left arm or in the right leg. Now, if parts which from these facts we may suppose to be in some connection are not affected, how can we expect the reproductive organs not only to be modified, but also to be so modified that the germs which are about to be budded off from them will be so affected as to produce exactly the same character—in this case enlarged muscle, etc.—without the application of the same stimulus, viz, exercise? Thus, while I freely admit that every alteration of an organ in response to external agents will react through the whole organization, affecting each organ in functional correlation with the affected organ in a way which will depend upon the function of the correlated organ, and possibly other organs not in functional correlation in an indefinite way and to a slight extent, yet I maintain that it is very hard to believe that it will have such a sharp and precise effect upon every spermatozoon and ovum subsequently produced that not merely will these products be altered generally in all their properties, but that one particular part of them—and that part of them always the same—will be so altered that the organisms which develop from them will be able to present the same modification on the application of a different stimulus. It is inconceivable; unless, indeed, we suppose that the very molecules of the incipient organs in the germ are more closely correlated with corresponding parts of the parent body than are the homologous parts of the parent body with one another.

Now, to prove the existence of such a remarkable and intimate correlation would surely require the very strongest and most conclusive evidence. Is there any such strong evidence? I think I may fairly answer this question in the negative. The evidence which has been brought forward in favor of the so-called inheritance of acquired characters is far from conclusive. That such evidence* exists I do not deny, but it is all, or almost all, capable of receiving other interpretations.

* For a good statement and discussion of the evidence in favor of this view, see Romanes' *Darwin and after Darwin*, Vol. II. chaps., 3 and 3.

EFFECT OF CHANGED CONDITIONS UPON THE REPRODUCTIVE ORGANS.

On the other hand, all the certain evidence we have concerning what happens when the reproductive organs are affected, either directly or by correlation, by a change of conditions—and, as we have seen above, they must be affected if there is to be any change in the offspring—tends to show that there is not any relation between the effect produced on the parent and that appearing in the offspring.

The only means of judging whether the reproductive organs are affected by external conditions is by observing any change which may occur in their function. Now, only two such physiological effects of a change of conditions are certainly known; these are (1) the production of sterility or of partial sterility; (2) the production of an increased but indefinite variability in the offspring. With regard to the first of these effects: One of the most common, or at any rate one of the most noticeable alterations in an organism, effected by change in the external conditions, is an alteration of the reproductive system, an alteration of such a kind that organisms which had previously freely interbred with one another are no longer able to do so. One of the most common results of removing organisms from their natural surroundings is to induce sterility or partial sterility. There is no reason to doubt that this sterility or tendency to sterility is, broadly speaking, due to an affection of the reproductive system. In the case of the higher animals, it may in some cases be due to an action upon the instincts, but in the lower animals and in plants we can hardly doubt that it is due to a direct action upon the reproductive organs. Indeed in plants these organs are often visibly affected. Among animals, however, there does not appear to be any satisfactory evidence on the point, and it is not known what organs are affected, whether it is the actual gametes, or the reproductive glands, or some of the other organs concerned.*

The other result of changed conditions which is certainly known is to induce an increased amount of variability of the genetic kind, though not immediately, often indeed not until after the lapse of some generations. On this point Darwin says: "Universal experience shows us that when new flowers are first introduced into our gardens they do not vary; but ultimately all, with the rarest exceptions, vary to a greater or less extent" ('Variation,' 2, p. 249).† With regard to the variability thus induced, it is to be noticed that it is not confined to any particular organ, nor does it show itself in any particular way. On the contrary, the whole organization is affected, and the variations are quite indefinite.

To sum up the argument as it at present stands: (1) a change in conditions cannot affect the next generation unless the reproductive organs are affected; (2) from a consideration of the facts of the case, it is almost inconceivable that the effect produced upon any organ of a given organism by a change of conditions should so modify the reproductive organs of that organism as to lead to a corresponding modification in the offspring without the latter being exposed to the same conditions; (3) the only effects, which are certainly known, of changed conditions upon the reproductive organs are (*a*) the production of sterility; (*b*) an increase in genetic variability.

* The exact cause of this sterility in the higher animals is a point which specially needs investigation.

† The phenomenon of increased variability following upon change of conditions has most often been observed when the change has been from a state of nature to a state of cultivation. Hence the conclusion has been drawn that the kind of change involved in domestication alone induces variation. But there is no evidence in favor of this view. The evidence shows that change of conditions in itself may induce greater variability.

As far then as our certain knowledge goes, it would appear that a change of conditions may have one or both of the following effects:

(1) A definite change, of the same character or nearly so, in all the individuals acted upon. Such changes may be adaptive or non-adaptive, but they are not permanent, lasting only so long as the change of conditions, or at most during the life of the individual acted upon. They are not transmitted in reproduction, and do not appear in the offspring unless it is submitted to the same conditions. These variations are the direct result of the action of the environment upon the individual, with the exception of the reproductive organs.

(2) Increase in the variations of the genetic kind. These are seen not in the generation* first submitted to the changed condition, but in the next or some subsequent generations. The effect is produced through the reproductive organs. These variations are non-adaptive, and different in each individual.

If the reproductive organs are affected we get an increase in the variations of the genetic kind. These, we have seen, are usually of an indefinite character; they are different in every case, and their nature cannot be predicted from experience. But we still have to ask: Is this a universal rule? Does it never happen that a change of conditions so affects the reproductive organs as to produce a definite non-adaptive change of the same character or nearly so in all the descendants of the individual acted upon? This is the most obscure question connected with the study of variations. If such changes occur, they might

* No doubt the individuals of the generation first submitted to the changed conditions would be affected as regards their reproductive organs, which would be altered in structure, but this has not been made out, though there are indications of such an effect in certain plants.

be cumulative, being increased in amount by the continued action of the conditions. They would be non-adaptive, their nature depending on the constitution of the reproductive cells and having no functional relation to the original stimulus.

As possible examples of such variation, I may recall those variations referred to by Darwin as 'fluctuating variations which sooner or later become constant through the nature of the organism and of the surrounding conditions, but not through natural selection' ('Origin,' ed. 6, p. 176); to the variations in turkeys and ducks which take place as the result of domestication ('Variation,' 2, p. 250); to those variations which Darwin had in his mind when he wrote the following sentence ('Origin,' p. 72): "There can be little doubt that the tendency to vary in the same manner has often been so strong that all the individuals of the same species have been similarly modified without the aid of selection."

It is, however, as I have said, extremely doubtful if variations of this kind really occur. The appearance of them may be caused by the combination of the two other kinds of variation. In all cases which might be cited in support of their occurrence, there are the following doubtful elements: (1) no clear statement as to whether the variations showed themselves in the individuals first acted upon; (2) no history of the organisms when transported back to the old conditions.

Moreover, a general consideration of the facts of the case renders it improbable that such similar and definite genetic variations should often occur at any rate in sexual reproduction. For although the effect upon the reproductive organs may possibly be almost the same in nearly all the individuals acted upon, it must not be forgotten that the reproductive elements have to combine in the act of conjugation, and that it is the essence of this act to produce products which differ in every case.

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(*To be Concluded.*)

THE LANGUAGE OF HAWAII.
II.

V.—SPECIAL PECULIARITIES.

Volubility.—The language of Hawaii is extremely voluble. The comparative ease with which the same ideas may be repeatedly expressed in a different form, and apparently as new material, is shown by the following incident which happened during my visit.

Owing to the mixed composition of the Hawaiian legislature, it is necessary to employ continually two languages. All speeches in English are immediately translated into Kanaka, and *vice versa.* On this occasion the interpreter innocently exposed a fundamental characteristic of the native tongue in replying to a member. An Hawaiian had spoken possibly ten minutes since his last words were translated. A friend, anxious that nothing of importance should be lost, asked why the interpreter did not perform his duty and give the English-speaking members the benefit of the words just uttered. The reply was: "He has said nothing fresh yet." The speaker had simply repeated in new phraseology the substance of his previous remarks, and so skillfully was it done that the friend, although somewhat conversant with the tongue, was misled by Kanaka volubility.

Here we have a distinguished feature in Polynesian methods of thought. By its very simplicity, its lack of generic terms, and its flexibility, the Hawaiian tongue is capable of almost endless expression of the simplest ideas. As we trace the growth of the language, influenced by the peculiar environment and temperament of the people, the causes of its unique construction become apparent. In illustration of this idea we shall add a few remarkable characteristics of Oceanic speech :

Three Numbers—They have three numbers: the singular, dual and plural. This appeared also in the parent speech of Western tongues, and was preserved in the Aryan, old Bulgarian, and in (Homeric and Attic) Greek; and however strange in English, is but one of the many traces of an early contact in the primitive tongues.

Throughout all Polynesia, and even as far east as the Indian archipelago, we find that peculiar, but very rational, idea which requires the use of a distinguishing word when the person addressed is included or excluded in the statement made. The rule applies both to the dual and plural numbers.

> *Hele maua* means we two went, *excluding* the person spoken to.
>
> *Hele kaua* means we two went, *including* the person addressed.

Of course, the first expression requires the presence of at least three persons ; the second admits the presence of only two.

> *Hele makou* means that we (myself and party) went, but not you.
>
> *Hele kakou*, we (myself and party) went, and you as well.

Changed Meanings of Words.—It is a fact frequently observed that one nation often takes a word from a foreign language and gives it a debased meaning in its own, much in the same spirit that one religion supplants another and makes the gods of the old one the devils of the new. *Apporter* (to carry) in French is transformed into *apportieren* in German and applied to dogs as a hunting term.

Take the word *manger*. With us it is for horses ; in French it means to eat, and applies also to men and women. The word saloon here means a low drinking place ; in France it is the parlor. These linguistic compliments are mutual between two of the Latin countries of Europe. The French word to speak (*parler*) is used in Spanish to designate one who talks too much and says little of importance (*parlero*). Reciprocally, the Spanish word to talk (*hablar*) serves a similar purpose across the Pyrenees, and a *Hableur* is one with many words and few thoughts, who goes about telling lies. Each nation, by implication, casts a slur on the other. We all know what it is to take French leave. So do the French—only they call the same thing going off, after the English fashion, *s'en aller à l'anglaise.* We speak of the leprosy being a disease of the Hawaiian islands. The Hawaiians call it *mai pake* (Chinese disease). The same principle was exemplified in Europe in the sixteenth century. The Italians called it French. These, in turn, threw it on the Spanish ; and so it went. No country was willing to father it.

These facts are cited by way of contrast with what took place in Hawaii. The tendency here was to give words and ideas absorbed through external intercourse an elevated meaning. Their conception of foreigners was one of superiority. Captain Cook was the personification of their God, and he is still spoken of as *Lono*, one of the four deities of Hawaiian mythology. No human being was ever feared or worshipped as he, and notwithstanding the tragic circumstances of his death, the natives could not entirely relinquish the supernatural idea, nor bring themselves to give up the illusion of a reappearance of their Savior, to which many still cling after long association with the whites.

It so happened that words that came to the natives through the medium of beings believed to be associated with the Gods were taken to represent better things than they originally designated.

Special Descriptive Terms.—The Hawaiian is a child of nature. Nothing can exceed the vividness with which natural things are portrayed. Almost every conceivable wind has a special name. *Kona* is a wind from the southwest; *hoolua*, a strong north wind; *ea*, the sea breeze at Lahaina; *ulumano*, a violent wind at night on the west side of Hawaii; *mumuku*, a wind blowing between two mountains; *kiu*, a northwest wind at Hana Kaupo; *hau*, a land breeze that blows at night; and so on almost indefinitely. Notice that special terms are given to local winds. Just how the sea breeze at Lahaina differs from that at other places does not appear; nevertheless *ea* applies to this locality and to none other.

Every day of the month has its special name. They count by nights and not by days. *Po akahi* means the first night, *i. e.*, Monday, *po alua*, the second night, or Tuesday, and so on. There are six different words meaning to carry; ten to express the different ways of standing; twenty that apply to various positions of sitting. This shows with what vivid imagery the Hawaiian describes the actions of everyday life. Here are a few examples of shades of meaning for the word carry:

hali,	to carry, in general.
auamo,	to carry on the shoulder with a stick.
ka'i ka'i,	to carry in the hands.
hii,	to carry, as a child in the arms.
koi,	to carry on a stick between two men.
haawi,	to carry on the back, etc., etc., etc.

When the missionaries came to translate the Bible they met an unexpected difficulty. It was necessary to decide between the ages of Mary and Martha, because it is impossible to speak of two sisters in the Hawaiian language without indicating which is the older. I do not know that anything is said in the Scriptures fixing definitely the relative ages of these two persons. The translators were obliged to decide from the context, in the absence of explicit and positive information on the subject.

The childlike and primitive character of the language is shown in the absence of abstract words and general terms, as also in the continual repetition of syllables. The first words pronounced by our own children are a repetition of two of the easiest sounds, pa-pa, ma-ma. The Hawaiians carry this to excess. Take the word *Humu humu nuku nuku apuaa*. This consists largely of repetitions, and is the name of a small fish considerably shorter than its name as ordinarily written. Here is another fish—*Muku muku wahanui*. However, in this case it suits Hawaiian ideas equally well whether you say Muku muku or Kumu kumu. The mere fact of a transposition of syllables is nothing in a language where there are 20 conjugations and where the verb has nearly 3500 forms.

Cadence.—Cadence is one of the prime features in all the South sea dialects. So essential is this considered that the tonic accent must be carried forward when an enclitic is employed. The stress is usually on the penultimate in the word *Lani* (heaven), but with the addition of *la* it falls on *ni*, and we say *ma ka laní-la*. *Ua mokú-la*, already given, is another example.

How much more rhythm is regarded in tropical than in northern languages may be seen by comparing the examples just cited with the Spanish, where they say *dême* for give me and *dêmelo* for give me it. No matter how many enclitics are employed, the accent is still retained in its original place.

Mathematical Ideas.—Examine their system of counting. The unit is four. This arose from taking cocoanuts and fish—two in each hand. After laying aside ten units of four, or forty they turned back and counted another forty. This process was continued for ten forties, which took the name of *lau*. Ten of these made 4000, or *mano;* and so they went on until 400,000 was reached, beyond which they had no conception. This was the old system. The missionaries introduced the modern way of going to ten (*umi*) then joining this with names previously used, as—

umikumamakahi, ten with one, for 11,
umikumamalua, ten with two, for 12 ;

and so on to twenty, which was *iwakalua*. Then the same method was continued, as:

iwakaluakumamakahi, twenty with one, etc.

There is no word in any of the Polynesian languages to express the idea of a definite fraction. Many words exist to indicate a part; but an aliquot part—something that is contained an entire number of times in the whole—was entirely beyond their mathematical powers.

Abundance of Words.—The peculiar character of the Hawaiian language is shown by the great number of words employed as compared with the Aryan tongues. Sometimes the ratio is three to one. We say, "Forgive our debts as we forgive our debtors." Eight words express the idea in English. Twenty-four must be employed in Hawaiian, since it is necessary to say:

E kala mai hoi ia makou i ka makou lawehala ana me makou e kala nei i ka poe i lawehala i ka makou.

A few examples will show how cumberbersome in a Polynesian tongue are some of the commonest and simplest terms in English. Take the word *across*. In Hawaiian this is *mai kekahi aoao a i kekahi aoao ae*, making eight words, and no shorter way of rendering the idea exists.

Daily would be expressed by *kela la keia la*, meaning that day, this day; being something akin to the Spanish locution for every other day, *un dia sí y otro no*.

Oratory, Religion, and Poetry.—Besides the ordinary language of life, there is a style appropriate to oratory and one to religion and poetry. Any one who has heard the Kahuna chant his incantations can never forget the doleful, plaintive tone which invariably accompanies such service.

The Hawaiians are passionately fond of poetry. They have no rhyme or meter in the modern sense, and no conception of the change of the length of feet, nor the shifting of the accent, which lends such a charm to English versification; but they have a style, highly figurative, appropriate to different classes of poetry.

There are, first, religious chants. Then the Inoas or name songs; these were composed at the birth of kings. Then came the dirges, and finally the Ipos or love songs. Here is an example of a dirge composed at the death of Keeaumoku and cited by Alexander in his history of the Hawaiian people. The translation is by Ellis:

Alas, alas, dead is my chief ;
Dead is my lord and my friend ;
My friend in the season of famine ;
My friend in the time of drought ;
My friend in my poverty ;
My friend in the rain and the wind ;
My friend in the heat and the sun ;
My friend in the cold from the mountain ;
My friend in the storm ;
My friend in the calm ;
My friend in the eight seas ;
Alas, alas, gone is my friend ;
And no more will return.

Imagery.—Notwithstanding the exceedingly primitive nature of the Hawaiian language, it has been successfully employed to express the abstractions of mathematics, and is found flexible enough to deal with law and theology. Of the three classes of words found in all languages, namely, those expressing sensations, images, and abstract ideas, the Polynesian dialects are most copious in the second. The several dozen words already cited, indicating different positions of the body during activity or repose, give abundant evidence of their love of imagery.

Their vocabulary is exceedingly rich in terms relating to the sea, the sky, and the surf; their cloud terms might well rival in exhaustiveness the scientific nomenclature of the modern student of meteorology.

Almost every stick in a native house bears its special name. Each one of the six houses, that every well-to do Hawaiian was supposed to have, before the advent of the whites, had its appropriate use and name.

These were—

1. The *Heiau*, where the idols were kept.
2. The *Mua*, the eating-house for the husband.
3. The *Noa*, or separate house for the wife.
4. The *Hale aina*, or eating-house for the wife.
5. The *Kua*, or the wife's work-house.
6. The *Hale pea*, or the hospital for the wife.

To fully understand these arrangements we must bear in mind that during the reign of the *tabu*, men and women never ate together under any circumstances. The food of the husband could not be cooked in the same oven used by the wife, and pork and many kinds of fish were absolutely prohibited to females; but they could eat dog and fowl.

The custom of applying a term connected with the position of the sun to designate a locality, common in other countries, finds usage in Hawaii. France has her *Midi*, Spain her *Levante* and *Poniente*, and the Kanakas their *Kau*. Kau means summer or warm season, and is used to designate the most southern province of Hawaii. In the first case we have the name of the hottest part of the day given to the territory, and in the latter the name of the hottest part of the year is so utilized.

Seat of Moral Powers—Parallel Italian Expressions.—The Hawaiians supposed that each man had two souls. One died with the body, the other lived on as a ghost, and was known by strange squeaking or whistling sounds (*muki*), like the ghosts which did 'squeak and gibber in the Roman streets.' Polynesian ethics also taught that the seat of the moral powers was in the small intestines. The word *loko*, which means *within*, was applied to the moral state or disposition. This idea was so prominent that large stomachs were cultivated as indicative of great moral strength. The word *papio* was applied to the act of lying face downward with nothing for the belly to rest on for the purpose of enlarging it and thus augmenting the moral powers.

This peculiar thought, after all, is not very far removed from that contained in the Italian expressions, *amico sviscerato*, bosom friend, and *un amore sviscerato*, an intense passionate love—literally a disemboweled love. No doubt the idea came through sources where a belief was held similar to that prevalent in Hawaii. Compare also *Mi ha levato un peso dallo stomaco*, He took a weight off my stomach; likewise the sentence, *Questa nuova vi ferirà nella parte più cara delle vostre viscere.* Besides, there has always been more or less connection, either expressed or implied, between the mind and stomach. It was in the Latin language that the original Greek word *στόμα* changed its meaning from mouth to belly. After this the step was easy from the organs of digestion to those of sentiment, and we find many examples in the Romance languages of this enlarged meaning of the original word. So the idea finds expression not alone in the South seas, but may be found cropping out all along the road of linguistic development, whether it be in Greece or Polynesia.

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COAL FLORAS OF THE MISSISSIPPI VALLEY.

The plant remains of the Trans-Mississippian coal field have received but scant notice. Something of their character is found recorded in the writings of Lesquereux, Newberry and others. These, however, are the merest glimpses, and give but faint conception of the actual extent and multiplicity of form that the floras of the coal measures present.

The idea has gained currency that the Carboniferous fossil plants of the Mississippi valley are most meagerly represented. The present note endeavors to point out that this widespread notion is wholly erroneous. In vastness, in great variety, in extensive geological range, in completeness of generic representation, in wealth of anatomical material, the fossil floras of the region are believed to have but few equals.

There are several reasons for the apparent paucity of plant remains in the beds of the coal measures. The preservation of the plants is confined almost entirely to the clay shales and shally sandstones. These readily break down under ordinary weathering influences into soft clays. The most prolific plant bed may be thus destroyed, giving scarcely a sign of its organic content. Even in coal mines the obliteration of whatever fossils exist goes on so rapidly that fossil ferns usually fail to attract notice. Only when the perfectly fresh shales are exploited purposely for their fossils can they be made to give up their botanical records.

Many plant remains are preserved or replaced by iron pyrite and quickly decomposed on exposure. The finest structures, displaying anatomical features in the greatest perfection, are frequently in this condition; but it is only when in the fresh state that outlines and markings of the cells are capable of being studied with satisfaction.

Probably the greatest drawback to the acquirement of a complete knowledge of the fossil floras is the lack of interest shown by local collectors. Few fossil gatherers give any attention whatever to the plants. The Paleobotanists are not given to making systematic collections themselves, but study only those scattered chance specimens in cabinets devoted to other fossil forms. As a result we have no complete plant collections.

From the paleontological literature we get only a faint glimpse of the Trans-Mississippian flora. Outside of a few isolated references the only account of an extensive flora is that of Lesquereux, whose material was obtained by Dr. G. H. Britts, of Clinton, Mo. The Britts' collections have been studied anew by David White, whose recent excellent monograph on the Fossil Plants of Missouri shows only too clearly how prolific may be the coal plants of a single locality and of a single horizon. No indication, however, is given regarding the vast possibilities of this coal district as a field for systematic exploitation along paleobotanic lines.

Attention is called in the monograph to some of the obstacles to accuracy in correlation and especially to the lack of standard paleobotanic sections. If ever there were opportunity of establishing a standard section it is in the Trans-Mississippian coal field. Plant remains occur abundantly in many localities and at many horizons, extending from the very base of Des Moines series, up through Missourian, into the so-called Permian. The monograph on the Missouri fossil floras considers chiefly one locality and one horizon. In Missouri alone there are no less than 150 known localities and 30 horizons for coal plants. In Iowa there are nearly as many more. Kansas likewise offers an equally inviting field. If a single location yields up such prodigious possibilities as Mr. White has demonstrated what may we not expect from the rest of the field?

Of Missouri localities furnishing fossil plants, Rich Hill, Kansas City, Lexington, Versailles, Huntsville, Macon and Moberly afford especially attractive fields for early exploration. Exceptional opportunities for the construction of standard paleobotanic sections are offered in the west-central part of the State. These are easily made in a direction east from Kansas City, along the

Missouri river, and continued in the Missourian series along the same stream north from the city. Or, a direction taken southeast of Kansas City is equally advantageous, besides passing through the Clinton district, and reaching into the old gorges in the Mississippian series which are exposed on the flanks of the Ozarks. Work along these lines, both in the floral and faunal fields were begun by the Missouri Geological Survey in connection with the detailed stratigraphical cross-sections, and much valuable material obtained, but the efforts had to be abandoned before the data were complete.

The exposures along the Des Moines and Raccoon rivers, in central Iowa, afford another excellent field for making up a standard paleobotanic section. Plant remains occur in many localities and at numerous horizons. Some exquisite things have been observed. Van Meter affords beautiful ternately divided fern fronds over a yard across. Mud Creek, below the city of Des Moines, furnishes, in profusion, plant-bearing nodules similar to Mazon Creek, in Illinois. Ford supplies structural specimens, showing the wood cells and their workings as perfectly as if they were taken from the living plant. Knoxville has extensive plant beds and the bluffs of the streams in Marion county often have tons of shale-slabs with plants in sight at one time. At one time the Iowa Geological Survey began to get material of this kind together for a report on the coal floras of the State supplementary to the reports on coal deposits. But since the appearance of the first volume of the latter nothing farther seems to have been done regarding the plants.

The main consideration, however, is the fact that the Trans-Mississippian coal field presents for the study of fossil plants a wealth of material unrivalled in the whole country. If standard paleobotanic sections of the region are lacking, it is certainly not because the fossil botanist lacks the material and opportunity to construct them.

Charles R. Keyes.

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*ON THE ZOO-GEOGRAPHICAL RELATIONS OF AFRICA.**

The speaker prefaced his communication by remarking that he had nothing absolutely new to bring forward, but that, inasmuch as some views which seemed to be contrary to evidence had been urged very recently, a presentation of the conflicting evidence was timely, if not necessary. The views in question were broached in 'A Geographical History of Mammals,' by Mr. R. Lydekker, and the address of the retiring president of the New York Academy of Sciences (Professor H. F. Osborn) published last week in Science (April 13th).

Beaumont's apologue of the shield has its counterpart for the fauna of Africa. It has two sides facing in opposite directions, and it cannot be understood without taking both into consideration. The proposition to combine Africa with Asia, Europe and North America into a realm contrasted with South America and Australia (or even to combine again Africa and India against the others) may apparently be justified if we look only to the present mammalian fauna, but if we revert to the past and consider other classes, we must be led to different conclusions.

The fishes are by far the most instructive in their teaching. Very recent discoveries recorded by Mr. Boulenger add force to their testimony. Those animals represent two very distinct assemblages. On the one side, we have Cyprinids of genera occurring also in India or very closely related to such genera. On the other side, we see numerous species belonging to families having no representatives in India or elsewhere than in tropical America. Such are the Cichlids,

* A communication to the National Academy of Sciences made April 18, 1900, by Dr. Theodore Gill.

the Characinids and the Lepidosirenids, which are the most prominent constituents of the African fauna. These families are also equally characteristic of tropical America, but the representatives of the two continents belong to different genera.

The deduction seems to be inevitable that the main element of the piscine fauna was derived from the same source as that of America. The fact that generic differentiation has supervened to such an extent suggests, if it does not prove, that the time that has elapsed since the derivation of the respective faunas is great. Equally inevitable appears to be the fact that the cyprinoid element has been derived from an Asiatic source, and the slight differentiations indicate that the introduction of that element has been comparatively recent.

If we now examine the piscine fauna of Madagascar we find that one of the most characteristic African genera (*Tilapia*) is developed in that island and that there is nothing in that fauna to contradict the evidence of that genus—that it has been derived from Africa or the same main source as the African species.

These views are identical with those promulgated a quarter century ago (in 1875) in the *Annals and Magazine of Natural History*, and then Africa and South America were associated together with Australia in a hemisphere called EOGÆA contrasting with another named CÆNOGÆA, comprising North America, Eurasia and India. The accumulating testimony of the succeeding years has added to the cogency of the argument.

If we now look at the mammalian fauna with the light thus reflected, we may appreciate facts of an analogous nature, but more obscured or complicated by recent interchanges of faunal constituents.

On the one hand are numerous and conspicuous mammalian types congeneric or closely related to Eurasian or Indian forms. On the other hand are many smaller and less obtrusive mammals peculiar to the continent and without any near relatives elsewhere in the present geological epoch.

It has been wisely said that "the final test of a scheme of zoological distribution must be the paleontological test." But the paleontology of Africa has not yet yielded the test. The evidence of paleontology, so far as it goes, points to the origin or development of most of the conspicuous animals of Africa elsewhere than on the continent. It is true that Africa has been declared to be especially the 'center of adaptive radiation during the Tertiary period' of the Proboscideans, as well as of the Hyracoideans. The evidence, for this claim, however, is only negative. At least, so far as the printed record goes, no early remains of Proboscideans or Hyracoideans have been found in Africa, and their former existence there apparently has been assumed because their remains have not been found in better explored lands. The assumption may be right, but it must not be forgotten that it is a pure assumption. Madagascar, however, can not be assumed with strict propriety to be the 'chief centre of adaptive radiation' of all Lemuroideans, inasmuch as that order was formerly widespread, and the great island is rather the last stronghold of the restricted group.

If, as Professor Osborn well urges, it "*is our problem to connect living distribution with distribution in past time and to propose a system which will be in harmony with both sets of facts*," with the facts of distribution of the fishes and even that of mammals in view, the association of the so-called Arctogæan realms is illogical and falsifies the record. Whatever facts a classification may be intended to embody, the African fauna must be isolated. If we wish to express, in our terminology, a former condition of affairs, Eogæa is a term adapted to do so.

SCIENTIFIC BOOKS.

The Theory of Electrolytic Dissociation and some of its Applications. By HARRY C. JONES, Associate in Physical Chemistry in Johns Hopkins University. New York, The Macmillan Company. 1900. Pp. xii + 289. Price, $1.60.

For several decades the dominant field in chemistry has been the study of organic compounds, and it is only within the last ten years or so that the tide has given evidence of turning in other directions. Chemical theory has been developed very largely in its application to organic chemistry and it is partly at least because these theories have proved inadequate in their wider and more general application that attention is being turned more strongly to inorganic chemistry and physical chemistry. There has always been a limited number of chemists who have confined themselves largely to inorganic chemistry, but the great impetus in this direction has come from Mendeleef's generalization of the periodic law, and the consequent necessity of studying closely the relations which subsist between the different elements. So, too, physical chemistry, that is, the study of the physical properties of chemical substances, has always attracted a few investigators. Perhaps the most notable workers have been Kopp, who determined and compared large numbers of physical constants of organic substances, and the founders of thermo-chemistry, Berthelot and Julius Thomsen. But with the work of van't Hoff and Arrhenius was called into being a new physical chemistry, one of the most important fundamental doctrines of which is the theory of electrolytic dissociation, and whose most influential teacher has been Ostwald. The *Zeitschrift für anorganische Chemie* and the *Zeitschrift für physikalische Chemie*, as well as the *Journal of Physical Chemistry* in this country, testify to the activity of the workers in these two newer fields.

The demands of teachers have also occasioned the production in physical chemistry of a very considerable text-book and reference book of literature, much of it far from satisfactory, as is naturally to be expected in a department of science young as yet, and hence in a very immature state. Some of these books attempt a survey of the whole field of the older and the newer physical chemistry, some dwell on the new almost exclusively. The book before us is less ambitious, aiming only to treat of a single, though the most important theory of physical chemistry of to-day. In doing this, however, a view of the relation of this theory to the whole field, and of the newer to the earlier physical chemistry is given. Dr. Jones is to be congratulated upon having written a book which, while brief, is clear and is readable.

The book is divided into four chapters: Chapter I. The earlier physical chemistry, 70 pages; Chapter II. The origin of the theory, 33 pages; Chapter III. Evidence bearing upon the theory, 67 pages; Chapter IV. Some applications of the theory, 112 pages; as far as space goes an excellent balance. In the preface the author states that these chapters seek to answer respectively the questions: "What was physical chemistry before the theory of electrolytic dissociation arose? How did the theory arise? Is it true? What is its scientific use?"

Chapter I. takes up first the work done upon the relations between properties and composition, and properties and constitution. A few pages then outline the development of thermo-chemistry. The next topic is development of electro-chemical theory; the later theories of electrolysis, Hittorf's work on the migration velocity of the ions and Kohlrausch's work on the conductivity of solutions, complete the connection between the older and newer physical chemistry, indeed, these last rather belong to the new. This chapter is completed by the development of chemical dynamics and chemical statics, including the law of mass action, and the work of Willard Gibbs. The treatment of these topics is necessarily brief, but it suffices well to lead up to the main topic of the book.

Chapter II. It is a curious fact that the origin of some of the great ideas of chemistry must be credited to those who were not chemists. The atomic theory, Avogadro's theory, the discovery of the inert gases are examples; so also the theory of electrolytic dissociation owes its origin to the osmotic investigations of a botanist, W. Pfeffer, working in the field of vegetable physiology. Pfeffer in 1877 published a series of quantitative studies of osmotic pressure, using the copper ferrocyanid cell, which was destined to be much used at a later period. At not far from the same time, ideas on the arrangement of atoms in space began to germinate in the mind of van't Hoff. "From this he (van't Hoff) was led to study reaction velocity, and from this the conditions of equilibrium. But closely connected with the problem of equilibrium was that of affinity. He took up, as an example of affinity, the attraction of salts for their water of crystallization, and sought to measure this more directly than had been done." It was at this point that his attention was called to the work of Pfeffer, and after studying concentrated solutions he turned to dilute. In 1887 just ten years after Pfeffer's work, van't Hoff published a paper entitled 'The Rôle of Osmotic Pressure in the Analogy between Solutions and Gases,' and in this shows the application of Boyle's law to dilute solutions. The next step was to show that Gay-Lussac's law also applied to dilute solutions, and finally that these could only be true on the assumption that the law of Avogadro was equally true, that is "that solutions which at the same temperature have the same osmotic pressure, contain in a given volume the same number of dissolved particles."

It soon however became clear that "the osmotic pressures of large classes of chemical substances do not conform to these laws. The exceptions include all the acids, all the bases and all the salts," that is electrolytes, and in all these the osmotic pressure is greater than would be expected. Thus far van't Hoff. The next step is taken by Arrhenius who reasoned that as the anomalous vapor density of ammonium chlorid, etc., was due to the dissociation of the compound into simpler molecules, so in dilute solution the salt is dissociated and this dissociation is into its ions, thus going back to Clausius' theory of electrolysis. In this way came into existence the theory of electrolytic dissociation as advanced by Arrhenius, which is briefly, that all electrolytes when in aqueous solution are dissociated to a greater or less extent into their ions, which are the positive and negative portion of the molecule laden with a charge of electricity.

Such is an outline of the development of the theory as traced in this chapter, much of it in the language of Pfeffer, van't Hoff and Arrhenius, and all of it lucid and logical.

Chapter III. is devoted to a presentation of the evidence for the theory. It is first shown that the physical properties of completely dissociated solutions should be additive, as is the case with dilute solutions of strong salts. Then the evidence from the heat of neutralization is given. The next section is perhaps the most important in the chapter, considering the relations between osmotic pressure, lowering of freezing point, rise in boiling point and electrical conductivity; it is just here that to the older chemists who have not been raised on this theory, the evidence for it appears most convincing, indeed it is the phenomena connected with these points which it is most difficult to account for on any other theory than that of electrolytic dissociation. Experiments to show the presence of free ions, effect of an excess of one of the ions and the relation between dissociation and chemical activity are the next subjects considered and the chapter ends with the effect of water on chemical activity. Numerous examples are given, taken largely from the work of H. Brereton Baker, showing the necessity of the presence of at least a trace of water in many chemical reactions.

For instance, dry chlorin will not act on metallic sodium; dry hydrochloric acid will not act on carbonates; dry hydrochloric acid and ammonia will not unite and dry sodium will not decompose concentrated sulfuric acid. Since the publication of the book, Baker has succeeded in distilling phosphorous in an atmosphere of dry oxygen. The question is now asked, "Why is water essential" and an answer is found "in that water has a very high dissociating power, breaking down the molecules into ions which then react. These facts are just what would be predicted if the theory of electrolytic dissociation is true."

Chapter IV. discusses first the application of the theory of electrolytic dissociation to solutions, and here are brought up a large number of the problems most interesting the physical chemists of to-day. This portion is particularly vivid, so much of it is descriptive of the author's own work. Here also is given Thomson's theory of the cause of electrolytic dissociation which while offering a simple explanation of the phenomena, has not as yet been fairly tested experimentally. The next section treats of the application of the theory to a physical problem, that of the seat of electromotive force in primary cells, and closely connected with this is a review of Ostwald's work on 'Chemische Fernewirkung.' Then follows the closing section on the application of the theory to biological problems with especial reference to the toxic action of ions.

Such is an outline of the book, whose perusal will well repay anyone who desires to become familiar with the most important phase of modern physical chemistry. It seems ungracious to offer any criticism of a book which limits itself to a definite field and so well carries out its aim, but after reaching the end of the book, one can hardly help feeling that he would like to hear the other side. The author's position is practically that of an advocate, and he makes the best of his case. It is true that he speaks of difficulties, but he does not discuss them or even allude to many of them. He says, indeed, "It has already been mentioned, and stress should be laid upon it, that there are facts to which the theory, as we now conceive it, does not seem to apply. But the evidence in favor of the theory is so overwhelming, in comparison with the few apparent exceptions, that we should examine the latter very closely before concluding finally that they are real exceptions. Without for a moment ignoring the facts for which the theory does not seem to entirely account, the writer believes that the evidence in favor of a great generalization being expressed by the theory of electrolytic dissociation is as strong as in the case of many of our so-called laws of nature. For how many of these apply under all conditions, and are entirely free from exceptions." But we wish the author had added a short chapter on these apparent exceptions, for if one reads his book to gain a knowledge of the theory, one desires to hear at least something of objections raised to it. As far as concerns aqueous solutions the theory seems to present an important and very useful generalization and yet it is not even here free from difficulties. It is also limited in its field in that it does not account for the fact of solubility, nor answer the questions why this salt is soluble, that insoluble ; and in that it applies only to electrolytes. Again, as soon as we leave the field of aqueous solutions we realize that the present statement of the theory is too narrow. The work of Franklin on liquid ammonia as a solvent presents many phenomena wholly inexplicable on the theory of electrolytic dissociation, and work with other solvents raises other difficulties.

That such advances have been made along the line of this theory, as yet hardly in its teens, is a source of wonder; but much more remains to be done. The greatest proportion of this work has been confined to aqueous solutions, but it is only by extending it to all manner of solvents that any comprehensive theory of solutions will be reached. This no one realizes more than Dr. Jones, who is applying his work to the alcohols and other solvents, and the same is true of other American chemists. Perhaps after all Dr. Jones' book is the more attractive, and even more useful, because its author has posed less as judge than as advocate.

The typography of the book and its general make-up are excellent, the proof has been very carefully read. One excellent innovation has been partially adopted, that of giving the year in addition to the volume in the references to periodical literature. This, while entailing little additional work upon the author, not only lightens materially the labor of one who is looking up the original literature, but it gives the reader a much more definite chronological idea of the subject-matter. The custom should be uniformly adopted in scientific literature.

The book is provided with a satisfactory index. JAS. LEWIS HOWE.

WASHINGTON AND LEE UNIVERSITY.

An Introduction to Physical Chemistry. By JAMES WALKER, D.Sc., Ph.D. London, Macmillan & Co., Limited; New York, The Macmillan Co. 1900. Pp. x + 355. Price, $2.50.

The author states in the preface that his main object in writing this new work on physical chemistry is to emphasize the important bearing of the principles of the science on the ordinary work of the chemist. The subjects discussed in the book are accordingly selected with this aim in view. Thus by far the larger part of the work is devoted to the consideration of the principles of physical and chemical equilibrium and their applications, and to a discussion of the theory of electrolytic dissociation and the explanations which it offers of the physical and chemical properties of salt solutions, while scarcely ninety pages are occupied by the description of the methods of atomic and molecular weight determinations and by the treatment of the theoretical conclusions derived therefrom in regard to valence, structure, and the relation of properties to atomic weight and to constitution. This is entirely rational from the point of view of the author; for though atomic and molecular weight determinations have great significance historically and theoretically from the fact that upon them is founded the structure theory of organic chemistry, in its comprehensiveness by far the most important theory that physical science has yet developed, it is nevertheless true that this theory is now employed without much reference to the physical relations on which it was originally based, so that a knowledge of the latter is not of great value from a practical standpoint. On the other hand, the electrolytic dissociation theory and the laws relating to equilibrium and reaction-velocity find constant application to the daily work of the industrial, the analytical, and the synthetic chemist.

It is scarcely justifiable to criticise the work adversely on account of the lack of system and logical sequence which it undeniably exhibits, for it is distinctly not intended as a complete, precise, and consistent presentation of the science of general chemistry, but rather as a direct accompaniment of a concrete and highly practical character to the instruction ordinarily given in other branches of chemistry. It is a book which is especially suitable for use in connection with the brief courses on theoretical chemistry which should be given to undergraduate college students. It is also admirably adapted to the needs of the teachers of elementary chemistry and of workers in allied sciences or in industrial chemistry who desire to acquire readily a knowledge of the more concrete and practical side of the subject. It is, nevertheless, the opinion of the reviewer that every thoroughly trained chemist, whether educated at a university or technological institute, should receive a more systematic, logical, precise, and thorough course in theoretical chemistry than that which the present work is intended to give, primarily in order that he may acquire the power of close and accurate thinking, in which students of chemistry are, unfortunately, as a rule, seriously deficient and inferior to students of physics, and secondarily that he may add to his store of specific chemical information a thorough knowledge of the underlying and related general principles—a kind of knowledge which cannot fail to be of great practical value to him, whether he engages in teaching or industrial pursuits. It is, however, unfortunately true that, with the possible exception of the recent work of Nernst, which has not yet been translated and which is too difficult of comprehension except for advanced students, there is no satisfactory text-book to accompany a course of the latter character.

The manner in which the task of the author has been executed is highly satisfactory. The work is written in a readable and unwearying style. The principles are clearly stated, and are always illustrated by concrete examples. The errors to which beginners are liable are especially pointed out. The treatment is a descriptive, not a mathematical one; but the author has not hesitated to employ mathematical expressions where greater clearness is thereby attained. The author, who has supplemented his university instruction in physical chemistry by more than ten years' experience in teaching and research, shows himself throughout the book to be a thorough master of his subject, to have a sound appreciation of the relative importance of the various principles and theories, and to be entirely free from one-sidedness and the desire for radical innovations.

The work is therefore of such a character as to justify the hope that it will mark the beginning of a new epoch in the teaching of general chemistry in this country and in England.

ARTHUR A. NOYES.
MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

Essai sur la classification des sciences. By EDMOND GOBLOT, Docteur ès lettres, Professeur au lycée de Toulouse, Ancien élève de l'École normal supérieure. Paris, Felix Alcan, editeur. Bailliere et Cie. 1898.

The excellence of this book, such as it has, lies rather in the way in which the details of the system of classification adopted are worked out than in any fresh or important general view of classification itself, in this respect differing widely from Spencer, whom the book aims largely to correct, and from Comte, whom it aims to complete. For this reason it is not easy to give in a few words a fair outline of this latest serious attempt to classify the branches of human knowledge.

One may say in general of Professor Goblot that his method is historical and critical. He does not attack the problem at first hand, but has continually in mind what has been done already in this field.

The author tells us that be began his study with the problem of immaterial wealth. This led him to study political economy in general; whence he passed to sociology. He discovered that sociology includes many things, logic among the rest, and that it was desirable to form a definite concept of, and to define if possible, this new science. This attempt led him inevitably to a general classification of the intellectual wealth of the race.

Of the two well-known meanings of the word science which we recognize in our English speech, a narrow meaning and a broad one, Mons. Goblot always has in mind the broad one, of which he regards the narrow meaning as a special case. All general knowledge, certain or probable, belongs to science. Philosophy is a part of science: even metaphysics, which, he argues, is either science or nonsense. He will have none of a *chose en soi.* So too there is no valid philosophy of the unknowable. The domain of science is the entire domain of human intelligence and interest. Even the arts are practical or applied sciences and must come into the general scheme.

Savants divide themselves into three groups according as they specialize: (1) mathematics, or (2) the physical and natural sciences, or (3) the moral sciences. Between the last group and the two first groups there is a deep gulf, partly on account of the almost exclusively literary training of historians, economists and sociologists, and partly by their traditions and habits of thought. The first two groups are closely allied.

Everything tends to show the present inferiority of the moral sciences. Although they have occupied the entire field of human interest from early antiquity, they are still poor in results and have neither a fixed object, principle or method. Just now they are making a show of becoming positive, of freeing themselves from metaphysics and taking rank among the sciences of nature. Psychology is about where astronomy was in the time of Tycho Brahe. It has already created for itself a method of observation and a technic and seems ready for a Kepler and a Newton. So psychology essays to become a true natural history of the human soul, and sociology of human society.

So we are coming to have not three, but two divisions of the sciences: (1) sciences of reasoning, deductive and abstract: and (2) sciences of observation, inductive and concrete.

Having maintained the radical opposition of the sciences of demonstration to those of observation there are only two roads to a proof of the fundamental unity of science: (1) the sciences of demonstration (the mathematical sciences) may be regarded as having passed through an early concrete stage to their present form: or (2) the sciences of nature, beginning in the concrete, are now passing forward and in part, have already progressed to the demonstrative stage. Mechanics and mathematical astronomy exemplify this tendency.

Of the two contentions named above the latter is, in point of fact, the one which the author adopts. The sciences of fact tend constantly to become more and more ideal until at last they free themselves from their original empiricism, have for object pure concepts, and proceed by abstract definitions and deductive demonstrations. The demonstrative sciences are the typical sciences: all other knowledge is on the road to this goal.

He does not think that our conception of the universe will become more and more simple, passing finally into one unique and supreme law. Rather in each order of knowledge there is a unique concept which serves to form all the other concepts of the same order. So he cannot with Comte conceive that the highest science consists in the co-ordination of scientific results. "This new specialty, the specialty of generalization is philosophy." No, says Mons. Goblot, the co-ordination of the results of science is purely literary work. It is the literateur and not the savant who has much to say of the 'majestic unity of sicience.' To specialize generalization is to specialize ignorance.

Historically, philosophy was at first simply science: the whole of science. Then it was science minus a few special sciences which began to be organized. And so this went on, philosophy being continually impoverished by new sciences which were formed from time to time. Philosophy is thus ever the residue: the yet unorganized part of human knowledge.

The book nowhere gives evidence of any considerable acquaintance with any branch of physical or natural science at first hand. It does show much acute thinking and a wide range of reading, especially in what the author would call 'the moral sciences.' Of the 296 pages in the book 169 are occupied with cosmology, biology, and sociology.

E. A. S.

GENERAL.

ANNOUNCEMENT is made by Messrs. Archibald Constable & Company of the preparation of a 'Victoria History of the Counties of England,' to be published in no fewer than one hundred and sixty large octavo volumes. According to the prospectus it "will trace county by county the story of England's growth from its prehistoric condition, through the barbarous age, the settlement of alien peoples, and the gradual welding of many races into a nation which is now the greatest on the globe. All the phases of ecclesiastical history; the changes in land tenure; the records of historic and local families; the history of the social life and sports of the villages and towns; the development of art, science, manufactures and industries—all these factors which tell of the progress of England from primitive beginnings to large and successful empire will find a place in the work, and their treatment be entrusted to those who have made a special study of them."

Mr. H. Arthur Doubleday, F.R.G.S., is the general editor of the whole series, and the plan of arrangement under sectional editors is as follows:

Natural History. Edited by Aubyn Trevor-Battye, M.A., F.L. S., etc. Geology, Paleontology, Flora, Fauna, and Meteorology contributed by specialists.

Prehistoric Remains. Edited by W. Boyd Dawkins. M.A., F.R S., F.S.A.

Roman Remains. Edited by F. Haverfield, M.A., F.S.A.

Anglo-Saxon Remains. Edited by C. Hercules Read, F.S.A., and Reginald A. Smith, B.A.

Ethnography. Edited by G. Laurence Gomme. Dialect and Place Names, Folklore, Physical Types contributed by various authorities.

Domesday Book and other kindred Records. Edited by J. Horace Round, M.A.

Architecture. The Sections on the Cathedrals and Monastic Remains. Edited by W. H. St. John Hope, M.A.

Ecclesiastical History and Political History. By various authorities.

Maritime History of Coast Counties. Edited by J. K. Laughton, M.A.

Topographical Accounts of Parishes and Manors. By various authorities.

History of the Feudal Baronage. Edited by J. Horace Round, M.A., and Oswald Barron.

Family History and Heraldry. Edited by Oswald Barron.

Agriculture. Edited by Sir Ernest Clarke, M.A., Sec. to the Royal Agricultural Society.

Industries, Arts, and Manufactures, Social and Economic History, and Persons Eminent in Art, Literature, Science. By various authorities.

Ancient and Modern Sport. Edited by the Duke of Beaufort.

Bibliographies.

It will be seen that the general scheme of the work is at once comprehensive, scientific, and complete. The history of each county will open with its geology, pass on to its paleontology, and so through the ascending scale of the floral and animal kingdoms until prehistoric man is reached.

THE Scientific Society of Colorado College has just issued Vol. 8 of *Colorado College Studies*, containing the following articles:

'Equations of Motion of a Perfect Liquid and a Viscous Liquid when Referred to Cylindrical and Polar Co-ordinates,' by Professor P. E. Doudna, 'The Capricorns, Mammals of an Asiatic Type, Former Inhabitants of the Pike's Peak Region,' by Dr. F. W. Cragin; 'Buchiceras (Sphenodiscus) Belviderensis and its Varieties,' by Dr. F. W. Cragin; 'The Number Concept,' by Dr. F. Cajori.

BOOKS RECEIVED.

Das Tierreich, 9 Lieferung, *Aves-Trochilidae.* ERNST HARTERT. Berlin, R. Friedländer und Sohn. 1900. Pp. ix + 254. Subscription price, 12 mark.

Bird Studies with Camera. FRANK M. CHAPMAN. New York, D. Appleton & Co. 1900. Pp. xiv + 214.

La spéléologie ou science des cavernes. E. A. MARTEL. Paris, Georges Carré & C. Naud. 1900. Pp. 126.

Æther and Matter. JOSEPH LARMOR. Cambridge, The University Press. New York, The Macmillan Company. 1900. Pp. xxviii + 365. 10s.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *American Journal of Science* for June contains the following articles:

Method of Studying the Diffusion (Transpiration) of Air through Water, and on a Method of Barometry. C. BARUS.

Separation and Determination of Mercury as Mercurous Oxalate. C. A. PETERS.

Electrical Resistance of Thin Films Deposited by Cathode Discharge. A. C. LONGDEN.

New Meteorite from Oakley, Logan County, Kansas. H. L. PRESTON.

Observations on Certain Well-Marked Stages in the Evolution of the Testudinate Humerus. G. R. WIELAND.

Chemical Composition of Sulphohalite. S. L. PENFIELD.

Phases of the Dakota Cretaceous in Nebraska. C. N. GOULD.

Geothermal Gradient in Michigan. A. C. LANE.

Production of the X-Rays by a Battery Current. J. TROWBRIDGE.

American Chemical Journal, May, 1900. "Preparation and properties of the so-called 'Nitrogen Iodide,'" by F. D. Chattaway and K. J. P. Orton. Preparation from iodine monochloride and ammonia; 'The action of reducing agents upon nitrogen iodide,' by F. D. Chattaway and H. P. Stevens. Decomposition with formation in every case of hydriodic acid; 'On certain colored substances derived from nitro compounds,' by C. L. Jackson and F. H. Gazzolo; 'The solution-tension of zinc in ethyl alcohol,' by H. C. Jones and A. W. Smith; 'Notes on lecture experiments to illustrate equilibrium and dissociation,' by J. Stieglitz; 'A contribution to the knowledge of tellurium,' by F. D. Crane. Method of purifying tellurium and detecting small quantities of it; 'The constitution of gallein and coeruleïn,' by W. R. Orndorff and C. L. Brewer; 'Permanganic acid by electrolysis,' by H. N. Morse and J. C. Olsen; 'On chlorine heptoxide,' by A. Michael and W. T. Conn.

J. ELLIOTT GILPIN.

SOCIETIES AND ACADEMIES.

SCIENCE CLUB OF THE UNIVERSITY OF WISCONSIN.

AT the meeting of the Science Club of the University of Wisconsin, held May 22d, Mr. J. B. Johnson presented a paper on 'Recently improved Methods of Sewage disposal.' The paper was devoted to a consideration of the principles underlying modern methods of treatment rather than the details of construction of sewage plants. The chemical and the bacteriological methods of sewage disposal were contrasted and the former shown to be too largely an artificial process, since it fails to make use of nature's effective agents—the bacteria—which when afforded suitable conditions change organic wastes into soluble products and finally into the inorganic nitrates and nitrites which constitute so largely the food of plants. The chemical precipitation plants were considered as belonging to a past stage in the development of sanitary science, and wherever installed are now looked upon as an incubus to be got rid of as soon as possible.

The combined septic tank and contact bed method, which was first used at Exeter, England, in 1896, and which is throughout a bacteriological method, Mr. Johnson regards as the most satisfactory solution of the sewage problem. The essential peculiarity of the method is that it affords in the septic tank to which the sewage is first conducted the ideal conditions for the action of the anærobic bacteria whose function it is to reduce the organic matter by putrefaction to soluble compounds. Further, in the coarsely porous and intermittently aërated contact beds, in which the soluble material from the septic tank is allowed to stand, are afforded the best conditions for the action of the aërobic or nitrifying bacteria. Experience with this method shows that even the solid material from the raw sewage, which in the septic tank is differentiated as a scum at the surface and a deposit at the bottom, is also slowly acted upon by the bacteria so that the quantity in the tank is not appreciably changed after the colonies have become firmly established. In the contact beds also the aërobic bacteria establish their colonies in a few weeks and appear in the form of slime, which adheres to the surface of the cinder or other porous material composing the bed. Before passing from the septic tank to the contact beds the effluent is aërated by allowing it to flow in thin films over weirs. "Perhaps never in the history of engineering," said Mr. Johnson, "has a new process, as revolutionary as this one, established itself so quickly with the highest authorities as has this new and simple method of sewage disposal."

In discussing the paper Mr. H. L. Russell likened the earlier attempts to accomplish the bacteriological purification of sewage in a single process to an attempt to raise the subtropical rice and the temperate to subpolar barley in the same field. Mr. F. E. Turneaure also discussed the paper, emphasizing both the cheapness and the efficiency of the new method. The paper and the discussion aroused much local interest, due partly to the fact that the city of Madison against the advice and the urgent protest of members of the Science Club, recently installed an expensive chemical plant for disposal of its sewage, but has now been compelled to abandon it as a complete failure and has elected Mr. F. E. Turneaure to be City Engineer.

Mr. Johnson's paper will probably be published as a Bulletin of the University of Wisconsin.

Officers of the Club for the ensuing year were elected as follows: Mr. E. A. Birge, President; Mr. C. S. Slichter, Vice-President; Mr. E. R. Maurer, Secretary and Treasurer.

WM. H. HOBBS.

DISCUSSION AND CORRESPONDENCE.

REPLY TO PROFESSOR KINGSLEY'S CRITICISM.

ONLY about a week ago my attention was called to the criticism by Professor Kingsley of my little book entitled 'Outline of Comparative Physiology and Morphology' in SCIENCE of April 27th. I delayed answering because I was at that time too much absorbed by many duties connected with the close of the academic year to allow my mind to be distracted by unpleasant matters. I am now at comparative leisure and undertake to show that many at least of his criticisms are unjust.

His points of criticism may be classified under several heads:

1. First and most numerous are general statements which are true but not without exceptions. This was unavoidable in a bare *outline* such as the work professed to be. Our distinctions in science are always sharper than in nature. This is especially true in elementary science. If exact details and all exceptions were given we should certainly fail to give a clear outline to be filled in by subsequent study. Under this head come—(*a*) the failure to make exception of Fungi in giving the broad distinction between animals and plants in the nature of their food. If I had attempted absolute exactness I should have been compelled not only to make exception of greenless plants, but to have discussed the economy of carnivorous plants, and the question whether all plants, even the greenest, do not supplement their mineral food with more or less of organic food. And then what would have become of my *Outline?* The very first necessity in an elementary work is to renounce much, very much that we should like to introduce. (*b*) Under the same head comes the statement that animals by virtue of the nature of their food must have a stomach, without mentioning some exceptions among parasites, as the tapeworm. (*c*) In speaking of the general absence of the middle ear in amphibians I did not make exception of Anura. (*d*) In omitting mention of distinct renal organs in Phyla lower than Mollusca. Surely these objections are hypercritical although in some cases especially (*c*) a foot-note might be added giving exceptions.

2. I said the last group may be regarded as

examples of hypercriticism, but there are other objections which are distinctly so. (*a*) I say, the olfactive nerve is specialized for the perception of odors, he objects that the *terminations* alone are thus specialized. This may be true, but is not the termination also included in my general statement? (*b*) I say a muscle is an arrangement for changing nerve-force into mechanical power. He apparently objects, but why he does not say and I cannot imagine. The statement is certainly true. (*c*) He reproaches me for certain important omissions, *e. g.*, the *mesodermal origin of metameres*. Surely this objection implies an attitude of mind wholly inconsistent with the writing of an outline.

3. A few of his criticisms are pure mistakes or else misunderstandings of my meaning. For example (*a*) he quotes me as saying that 'no voice is known below hexapod insects' and cites the stridulation of spiders and crustaceans. I did not say so. I said '*below this department*,' *i. e.*, *arthropods*. (*b*) I state that homologies are not distinctly traceable beyond the limits of a Phylum. The cases of homologies beyond these limits which he mentions are not certainly examples of homology but of analogy, not evidences of common origin but of adaptive modification. But in any case it must be remembered that I was tracing homology only in the clearest cases and as an argument for Evolution. (*c*) He says I omit all mention of branchiæ in Asterias although I mention them in Echinus. Is he sure that there are any such in Asterias? Perhaps they are among the newest things which he accuses me of neglecting.

4. Some of the objections he makes concern points still in doubt, *e. g.*, the function of the pedicillariæ in echinoids. The function I gave, viz, that of carrying food to the mouth, is still held and is not inconsistent with that which he probably had in mind, viz, the cleansing of the body.

5. Besides these there are, I frankly acknowledge, some real mistakes. It would be strange if there were not. For pointing out these I most heartily thank him. I will profit by his criticisms.

But I fear I weary the reader with personal matters which are of little importance. It is with real pleasure therefore that I hasten on to take up the last point, which is one of great interest in the general field of scientific thought.

6. The worst fault which Professor Kingsley finds in my book is '*the recognition* of a *vital force*.' Now this really amuses me. Surely Professor Kingsley must be ignorant of the early history of discussions on this subject or he would be aware that I was myself among the earliest enforcers of the doctrine of 'the correlation of vital with physical and chemical forces and the conservation of energy in the phenomena of living things.' I even suffered somewhat from the odium theologicum on that account. That my contributions to the discussion were not unimportant see the references given below.* The position I held then is so universally acknowledged now that the history of the discussion has lost something of its interest to the present generation. But some would go farther. In the revulsion against the *old idea of vitality* as an independent supra-natural force unrelated to the other forces of nature the scientific mind swung too far in the contrary direction, and it become the fashion for scientific men to ridicule even the use of the term *vital force* as the useless remnant of an old superstition and indicating a wholly unscientific attitude of mind; and thus gradually arose an odium scientificum forbidding the use of the term on pain of being thought unscientific. And yet the same men who repudiate life as a force talk serenely of gravity as a force or chemical affinity as a force, or the force of attraction or of inertia, wholly unconscious of any inconsistency in their position. The fact is, all of these stand on the same footing. They are *none* of them forces in the old sense of independent entities—they are *all* of them forces in the sense of *different forms* of the one universal energy, they are all *derivable from and convertible into* one another. They are all different forms of energy, determined by different condi-

**Am. Jour. Sci.*, Vol. 28, p. 305, Nov., 1859; *Phil. Mag.*, Vol. 19, p. 133 and 243, 1860; *Pop. Sci. Monthly* for Dec., 1873; *Carpenter's Physiology*, 7th ed., p. 7; McGee, Fifty Years of Am. Sci.; *Atlantic Monthly* Sept., 1898.

tions, giving rise, each, to its own characteristic group of phenomena, the subject matter of its own peculiar department of science. For convenience we give them names. Now the group of phenomena characteristic of living things is a more peculiar group than any other lower group, and therefore the determining form of energy *better deserves a distinctive name* than any other and lower form.

But some one will say: "vital force is a metaphysical conception and as such has no place in science." If so, then must we banish also all ideas of force, or power, or cause as metaphysical. The fact is, science cannot get on without metaphysical conceptions. We strive in vain to realize a science such as Comte imagined—a mere succession of phenomena following one another like the trooping shadows of a phantasmagoria *without causative nexus between*. Comte repudiated the idea of atoms and of a hypothetical ether as metaphysical ideas, and yet, who can estimate the service done to science by these ideas?

These views I have maintained for the last 30 years. In spite of the odium scientificum I have continued to use the term *vital force*, not indeed in its old sense but in a true rational sense. But the reaction toward a more rational view is now fairly on. It may again go a little wrong. I cannot sympathize entirely with all the recent views on this subject. Some of them seem to smack a little of the old supra-naturalism, but it will come right in the end. Meanwhile, I would commend to the attention of all who, like Professor Kingsley, are afflicted with a dread of *vital force*, an article in the *Monist* for July, 1899, entitled 'Biology and Metaphysics,' by that acute thinker and lucid writer, Professor C. Lloyd Morgan, as being altogether just. Professor Morgan is admitted to be an exact and painstaking biologist; but he is also what is far better and rarer, a profound and philosophic thinker.

Perhaps I have already said too much. All I can ask is that those interested, unbiased by the fault-finding criticism, will examine for themselves in a fair and sympathetic spirit. I do not fear the result.

JOSEPH LE CONTE.

BERKELEY, CAL., May 24, 1900.

GLACIAL EROSION IN THE WHITE MOUNTAIN NOTCHES.

TO THE EDITOR OF SCIENCE: In *Appalachia* for March, Professor W. M. Davis discusses the glacial erosion of certain over-deepened valleys in the Alps and the relation that is borne to them by the hanging valleys of their tributaries. He suggests that "the head of the Saco valley in the White mountains below Crawford notch deserves examination to see how far its smooth sides and U-shaped cross-section may be explained as the results of glacial scouring by an ice stream that hurried through the deep opening in the White mountain mass." The present note may throw some light on this question.

It is in the first place remarkable that, although there are valleys of east and west trend in northern New Hampshire, all the deeper notches and passes practicable for roads through the main mountain group extend from north to south, as would be natural if the notches had been deepened by ice streams moving in the general direction of the glacial striæ in New England. Moreover, Carter notch as seen from a distance, the Crawford notch as seen from Mt. Willard, and Franconia notch, all present essentially U-shaped cross-sections, their troughs being bordered by continuous cliffs rather than by projecting spurs, thus suggesting erosion in a roughly horizontal direction along the sides of a glacial channel, rather than down-hill erosion by streams on the side slopes. In the second place, if one climbs Carter dome from the notch, the path is so steep for the first eighth of a mile that one must cling to the trees to ascend it; but then there suddenly comes a gentler slope. As a boy I climbed the western wall of the White mountain or Crawford notch by way of the bed of Brook Kedron, south of the Willey House, and found it so steep as to be almost impracticable; but here again a point was reached from which the stream was seen coming leisurely over the plateau south of Mt. Willey before its plunge down to the Saco on the floor of the main valley. Standing on Mt. Willard, one looks east across the notch trough to where the Silver and Crystal cascades slip and leap down over the shining ledges, now and then disappearing in narrow clefts that they have worn in the rock; but above the cascades, one sees the wooded valleys of the streams as mountain hollows enclosed by gradual slopes that lead up to the heights north of Mt. Webster. These features seem to correspond to the hanging valleys of the Alps, although their dimensions are comparatively insignificant. East of Mt. Washington, the point of the spur between Tuckerman's and Huntington's ravines has the appearance of having been sheared off; and over the verge of the steep slope thus formed swings the white thread of Raymond's cataract, recalling the gauzy veils of the Yosemite cliffs.

Another characteristic of the glaciated and over-deepened Alpine valleys with their cliff walls is repeated in the rock falls from the sides of the White mountain valleys. The floor of Carter notch is heaped with rough rock fragments, forming two little ponds. The avalanche that killed the dwellers in the old Willey house is famous; the sides of the upper Saco trough towards Crawford notch are scarred with the paths of many other slides; and the Saco flows beneath heaped granite blocks that have fallen from the enclosing cliffs. Long talus slopes descend from the foot of the shear cliffs of the Franconia notch. These phenomena are not normally characteristic of mountains so old as those of New Hampshire, although they seem appropriate enough to ice-cut notches in old mountains.

The notch streams are not large enough to have produced prominent waste fans; yet north of the gate of Crawford notch—evidently the old divide—the streams which come down from the east and west, in Gibb's falls and Beecher's cascades respectively, have built a double fan where the Crawford house now stands, thus forming a new divide, on which one stream turns south to form the Saco. Probably the waste here was largely accumulated as a delta when the district to the north was a glacial lake that had its outlet southward over the old divide into the notch. The attitude of the headwaters of the north-flowing Peabody river would indicate that they had been diverted similarly from a southern course into the south-flowing Glen Ellis river by a waste filling on the floor of Pinkham notch near the old divide.

The general form and the recent changes in the White mountain notches thus indicate that they are the result of strong glacial erosion along the course of north and south valleys.

PHILIP EMERSON.

LYNN, MASS.

FLOATING SAND AND STONES.

PERUSAL of Dr. Erland Nordenskiold's description (*Nature*, vol. 61, p. 278, January 18, 1900) of the floating stones which he observed during his journey along the southwestern coast of Patagonia and of Professor Simonds's discussion of the topic in SCIENCE (Vol. XI, N. S., pp. 510–512, March 30, 1900), prompts me to add a locality to those already mentioned at which sand and stones have been observed floating on water. While camping on the 'Thumb,' or West Arm, of Yellowstone Lake, Wyoming, in July, 1899, the writer and other members of the party, among whom were several geologists, saw dark patches from two to six inches in diameter on the surface of the lake. These patches were numerous near the shore, and occasional ones were noted as far out as we could see. Examination showed that they were composed of the coarse black and red obsidian sand which forms much of the lake shore. The sand consisted for the most part of subangular particles 2 or 3 mm. in diameter, but pebbles 5 or 6 mm. across were frequently seen, and at least one fully 10 mm. long and rudely ellipsoidal in shape was observed by the writer among these floating aggregations. The material was solid glass, not cellular, and probably had a specific gravity of 2.345 (see J. P. Iddings, in 7th Ann. Rep. U. S. G. S., p. 291). The sand was not very dry, on the other hand, it seemed to be rather damp, when it was picked up from the shore by the gentle ripples and carried out by the moderate current produced at this locality by the inflow from an adjacent hot spring area. Ripples which did not break the surface of the water did not destroy the patches of floating sand, but crested wavelets precipitated the particles at once and stopped the formation of other patches along the shore line. The conditions therefore at this locality are a sand composed of material somewhat repellent to water and motion of the water strong enough to lift the particles of rock without agitating them enough to overcome the surface tension of the water. Here, again, as has been noted by other observers, the fine particles appear to gather about the larger ones and help to support them.

E. O. Hovey.

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DIURNAL RANGE OF TEMPERATURES.

To the Editor of Science: In the last issue of Science, page 872, attention is called by Professor R. DeC. Ward to a remarkable diurnal range of temperature. Nothing is said about the elevation or other conditions of the point of observation, but the article calls to mind my own experiences near the summit of Mauna Kea, on the Island of Hawaii. We were in camp on the shore of Lake Waiau nearly a week in July, 1892. The elevation was slightly over 13,000 feet—2000 feet above the last limit of vegetation, and about 1000 feet below the summit. The thermometer, always occupying the same position, read 13° F. at night and 108° in the daytime.

E. D. Preston.

EOGÆA AND ANTARCTICA.

To the Editor of Science: At last I send an abstract of my remarks 'On the zoo-geographical relations of Africa,' given at the last session of the National Academy of Sciences. I have been obliged to omit some points for want of time. As I find that some of my views long ago promulgated have been overlooked, or are being taken up now as new and attributed to others, I take this opportunity to refer to several articles, including especially such as have been published in Science:

1. 'On the Geographical Distribution of Fishes.' (*Ann. Mag. Nat. Hist.* (4), XV., 251–255, April, 1875.)

2. 'Fish.' (Johnson's New Univ. Cyclopædia, II., 116–119, 1876.)

3. Wallace's 'Geographical Distribution of Animals.' [A Review.] (*The Nation*, XXIV., 27, 28; 42, 43, July 12 and 19, 1877; reprinted (*Field and Forest*, III.), 69–74: 78–80; 98–101, 1877.)

4. 'Zoological Geography.' (Johnson's New Univ. Cyclopædia, IV., 1754–1760, 1878.)

5. 'The Principles of Zoogeography.' A presidential address, etc. (*Proc. Bio. Soc. Wash.*, II., 1–39, 1883.)

6. 'A Comparison of Antipodal Faunas.' (*Nat. Acad. Sc. Memoirs*, VI., 89–124, 1894.)

7. 'A Text-book of Zoo-geography.' By Frank E. Beddard. [A Review.] (Science, N. S., II., 272–274, August 30, 1895; Corrections, 342, Sept. 13, 1895.)

8. 'The Early Segregation of Fresh-Water Types.' (Science, N. S., II., 678, 679, Nov. 22, 1895.)

9. 'The Origin and Relations of the Floras and Faunas of the Antarctic and Adjacent Regions.' (Science, N. S., III., 305–320, February 28, 1896.)—'Vertebrata of the Land: Fishes, Batrachia and Reptiles.' (*Op. cit.*, 314–317.) 'Vertebrata of the Sea.' (*Op. cit.*, 319–320).

10. 'Principles of Marine Zoo-geography.' (Science, N. S., III., 514–516, April 3, 1396.)

11. 'The Distribution of Marine Mammals.' (Science, N. S., V., 955, 956, June 18, 1897.)

Theo. Gill.

Washington, May 28, 1900.

NOTES ON PHYSICS.

THE ABSORPTION OF LIGHT IN A RAREFIED GAS AND THE SUN'S CORONA.

Mathias Cantor in the *Annalen der Physik* for March, 1900, describes an experiment showing that a rarefied gas through which an electric discharge is passing has no perceptible absorption spectrum corresponding to its emission spectrum, and Professor G. F. Fitz Gerald in *Nature* May 3, 1900, remarks that this fact confirms the suggestion that the sun's corona is an aurora around the sun (an electrical discharge phenomenon) inasmuch as the bright spectrum line of the corona is not represented by a dark line in the solar spectrum.

The absence of an absorption spectrum corresponding to the emission spectrum of a rarefied gas through which an electric discharge is passing is very likely due to very great concentration of kinetic energy, among a few types of the molecular motion of the gas so that in regard to its emission the gas is potentially at an excessively high temperature.

MODERN VIEWS OF MATTER.

Professor Oliver Lodge in the *International Monthly* for May reviews the modern views of matter touching more particularly upon J. J. Thomson's electro-corpuscular theory, and upon Johnstone Stoney's electron theory. It has been known since Maxwell's time that a moving electric charge stores kinetic energy so that work is required to set it in motion and it does work when it is stopped, that is, an electrical charge is endowed with that most perplexing property of matter inertia. Johnstone Stoney's theory is that atoms of matter are aggregrates of electrons, an electron being, as it were, a stretched spot in the ether or a very small electric charge. J. J. Thomson's corpuscular theory is more or less similar to the electron theory only that J. J. Thomson has pretty clearly shown by experiment that what he calls a corpuscle exists, that its mass (inertia) is about 1/500 of the mass of the hydrogen atom and that it carries a definite negative electric charge.

In a very interesting communication to *Nature*, May 10, J. J. Thomson shows that many physical phenomena can be interpreted in terms of his corpuscular theory ; for example the proportionality of thermal and electric conductivity, and the variation of electrical conductivity with temperature.

W. S. F.

NOTE ON A NEW ABYSSAL LIMPET.

Under the name of *Bathysciadium conicum* Dautzenberg and H. Fischer have described* a new deep water limpet which combines some curious characters. The specimens are simply conical with radiating riblets and an almost membranaceous shell, and have a diameter of 1.5 mm. and a height of 0.9 mm. Some anatomical details are given by Dr. Pelseneer in a note appended to the description. The animal was obtained from the beak of a cuttlefish dredged by the Prince of Monaco off the Azores in 843 fathoms.

Like *Lepeta* it is without eyes or ctenidia, the respiration being carried on by the surface of the mantle. The muzzle appears to be without lappets, the right tentacle has an appendix like that of *Cocculina* (supposed to be a degenerate verge), there are no posterior filaments; an unpaired mandible and long radula are present, the nervous system is that of the Docoglossa and the otoliths are single.

* Bull. Soc. Zool. de France, xxiv., p. 207.

Dr. Pelseneer regards the genital gland (otherwise strictly docoglossate) as hermaphrodite, a condition so exceptional, and, considering the minute size of the animal, so difficult to determine, that judgment may fairly be suspended pending further confirmation of it. The radula as figured leads to the belief that except in the absence of the rhachidian tooth (often degenerate in abyssal limpets) the teeth are like those of *Lepetella;* the major lateral being broken into three pieces which have been taken for three separate teeth by the author cited. If this suspicion be correct the formula is $1 + 2 \cdot 0 \cdot 2 + 1$, for a transverse series of the radula. The creature will be the first true limpet (Docoglossa) to show any trace of a verge, and if really hermaphrodite, the first to exhibit this character. The single otolith is very likely correlated with the small size of the animal. The genus will stand next to *Lepetella* among the Abranchiate Docoglossa.

Wm. H. Dall.

THE PLANET EROS.

A letter from the Arequipa Station of the Harvard College Observatory of June 1, 1900, gives details concerning four photographs of Eros taken there in April with the Bruce telescope, by Dr. Delisle Stewart. An adjacent star was followed in an eye piece and by means of a micrometer screw the photographic plate was moved with regard to it by an amount and in a direction equal to the motion of Eros. The stars thus appeared as trails and Eros as a point. Approximate positions were determined from the plates at Arequipa with the results given below. Paper prints of two of these plates were sent to Cambridge and measures of them are also given. The negatives are now on their way to Cambridge, and as soon as received accurate positions will be derived from them.

These appear to be the first observations of Eros since its conjunction with the Sun. The second observations taken a month later are given in the accompanying bulletin. Efforts have been made at Cambridge to observe Eros, both visually and photographically, but have failed, owing to twilight.

Plate.	Date 1900.	G. M. T.	R. A. 1900.	Dec. 1900.
A 4333	April 26	$21^h\ 20^m$	$22^h\ 49^m\ 21^s$	$-5°\ 46'.0$
"	"	"	49 23	−5 46 .4
A 4334	"	22 06	49 27	−5 45 .8
A 4338	April 27	21 47	51 23	−5 29 .6
A 4341	April 30	21 16	57 7	−4 42 .1
"	"	"	57 1	−4 42 .

A LETTER has been received at the Harvard College Observatory from Professor H. A. Howe, at Denver, stating that Eros was observed with the 20-inch refractor of the Chamberlin Observatory with the following results:

Gr. M. T.	Apparent R. A.	Apparent Decl.	Comp. Stars.
May 27, 90729	$23^h\ 47^m\ 3^s.43$	$+2°\ 46'\ 27''.3$	Boss 8197
May 27, 91859	23 47 4 .37	+2 46 38 .6	Boss 8198

After taking parallax and aberration into account, a comparison of these observations with the ephemeris of J. B. Westhaver in A. J. No. 479 gave the following corrections to that ephemeris:

Gr. M. T.			
May 27, 90729	$+1^s.7$	$+28''$	Estimated Magn. 13.
May 27, 91859	+1 .5	+28	

So far as known this is the first visual observations of Eros since its conjunction with the Sun.

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*THE CAMBRIDGE EXPLORING EXPEDITION TO THE SIAMESE-MALAY STATES.**

ALL the members of this expedition have now returned to England. After the arrangement of the necessary preliminaries at Pangkok, the party proceeded to Singora, where the active work of the expedition commenced by an exploration of the Inland Sea, which measures, roughly speaking, 60 miles by 20. The birds' nest islands were visited and the now somewhat rare method of tree-burial investigated, as well as the habits of a peculiar, isolated tribe called Phram who are believed to be of Indian origin. The tree-graves were usually cigar-shaped wrappers, or rather shells made of laths and suspended horizontally at a height of six to eight feet from the ground between two tree-trunks, branches, or posts. The corpse is exposed in one of these shells (the heels being generally left higher than the head) and allowed to decay till the bones are clean, after which the bones should be collected and burnt. Box-like receptacles on posts, as among the Madangs of Borneo, are occasionally substituted for the wrappers. On this journey some strange articles of diet were served up to the two members of the expedition, among them being red ants, toads, bee grubs, and a species of cicada. The manner in which the latter are caught is peculiar. Two or three natives gather at night round a brightly-burning wood-fire, one of them holding a lighted torch. The others clap their hands at regular intervals and the cicadæ, attracted by the noise and guided by the light, fly down and settle upon the people as they stand by the fire. On this same journey a couple of young leopard or panther cubs were picked out of their nest in a hollow tree by the roadside. But it was found difficult to feed them, and they were therefore suckled by a Siamese woman who claimed to have previously suckled a bear.

From Singora the party proceeded to Patani, and ascended Gunong Besar or Indragiri to a height of 3000 feet. The next place visited was Biserat, in Jalor (Jala), which proved an excellent collecting ground until smallpox broke out. The limestone caves here were thoroughly explored, including the fine Gua Gambar or Statue Cave, containing a colossal figure of Buddah about 100 feet in length. The party then proceeded by the overland route through Raman, Ligeh, Ulu, Kelantan, and up the Lebih, a distance of about 200 miles, performed by elephants, rafts, and boats, as far as Kuala Aring. Hence Mr. Skeat, with six Malays, set out on a scouting expedition to explore the route to the Tahan Mountain, the highest peak in the Malay Peninsula, which reaches an altitude of about 10,000 feet. Mr. Skeat's party was absent about five weeks from camp, and got sight of an unrecorded peak named Gunong Larong, or 'Coffin Mountain,' not much inferior to the Tahan Mountain.

The expedition then descended to the coast, and after spending about two months in the

*From the London *Times*.

chief towns of Kelantan and Trengganu, proceeded by steamer to Penang, whence Mr. Evans paid a visit to Pulau and Bidan, Messrs. Yapp and Laidlaw ascending Gunong Inas. Mr. Skeat proceeded to Kedah to study the aboriginal Jungle-tribes of the interior.

It is understood that the expedition has been eminently successful, and has brought back very extensive zoological, botanical, and ethnological collections. The results obtained should be of value for purposes of comparison with the results of the recent successful Cambridge Anthropological Expedition of Dr. Haddon to the Torres Straits, Sarawak, and New Guinea.

The party was under the leadership of Mr. Skeat, of Christ's College, Cambridge, and comprised Messrs. Evans and Annandale, of Oxford, and Messrs. Yapp, Laidlaw, and Gwynne-Vaughan, of Cambridge.

SCIENTIFIC NOTES AND NEWS.

Mr. O. H. Tittmann will succeed to the superintendency of the United States Coast and Geodetic Survey, filling the vacancy caused by Dr. H. S. Pritchett's election to the presidency of Massachusetts Institute of Technology.

Lord Rayleigh has been appointed by the British Government chairman of a committee which is to investigate gunpowders and designs of guns with which they may be used to the best advantage.

Dr. Ed. Suess, professor of geology in the University of Vienna, has been elected a foreign associate of the Paris Academy of Sciences in the place vacant by the death of Sir Edward Frankland, and Sir John Burdon-Sanderson a correspondent in the place of the late Sir James Paget.

Dr. S. L. Tornquist, of Lund, has been elected a foreign member, and Professor F. Sacco, of Turin, a foreign correspondent, of the Geological Society of London.

The Paris Academy of Medicine has elected Professor Röntgen, of Munich, a foreign associate.

Professor W. C. Brögger, of the University of Christiania, at the invitation of the University of Chicago, delivered in Chicago his lectures on the 'Principles of a Genetic Classification of Igneous Rocks,' recently delivered at the Johns Hopkins University. The lectures were attended by geologists from Illinois, Michigan, Wisconsin and Minnesota.

Mr. Cecil B. Crampton, assistant in the museum at Owen's College, Manchester, has been appointed an assistant geologist on the Geological Survey of Scotland.

Columbia University will confer its LL.D. on President Arthur T. Hadley, of Yale University, on Lord Pauncefote, the ambassador of Great Britain, and on Mr. Thomas B. Reed, late speaker of the House of Representatives.

Professor Jacob E. Reighard, professor of zoology in the University of Michigan, will deliver the address at the dedication of the new museum building of Alma College, Alma, Mich., on June 27th.

Dr. Walter J. Swingle, agricultural explorer for the United States Department of Agriculture is in Algeria. He is about to forward date palms to Arizona, in order that they may be tested there.

The prizes offered by the National Geographical Society for the best essays on Norse discoveries in America have been awarded to Mr. Charles B. Dalton, of New York City, and Mr. K. F. Murray, of Norfolk, Va.

General W. A. Greely, Chief Signal Service Officer, has given directions for the establishment of stations for wireless telegraphy in the harbor of San Francisco, in Porto Rico and the Philippines.

The death is announced at the age of 87 years of M. Ravaisson Mollien, formerly professor of philosophy at Rennes, inspector general in the Department of Higher Education and curator in the Department of Antiquities at the Louvre. He was the author of many works on philosophy and æsthetics. The death is also announced of M. Hippolyte Stupuy, at the age of seventy years. He was curator of the artistic collections of the City of Paris and the author of works on philosophy and of a biography of the mathematician, Sophie Germain.

A donor, who wishes not to have his name mentioned, has presented to the American Museum of Natural History the collection exhibited by Messrs. Tiffany & Co. at the Paris Exposition, consisting of American and foreign cut and uncut precious stones and other objects. The value of the gift is over $50,000.

WE learn from *Nature* that by the will of the late Mr. G. J. Symons, F.R.S., a valuable bequest is made to the Royal Meteorological Society. He bequeathed to the Society all his books, pamphlets, maps and photographs, a copy of which is not already in its library. He also bequeathed the testimonial album presented to him by the Fellows of the Society in 1879 and the sum of 200*l*.

THE Brooklyn Institute of Arts and Sciences has received from an anonymous friend $5000, to be added to the endowment fund of the Institute.

WALTER S. DICKSON, of Salem, Mass., has bequeathed $10,000 and a fifth of his residuary estate to the public library of that city and $10,000 conditionally to the Essex Institute. John Curtis has bequeathed $15,000 for a public library building at Hanover, Mass. The Hon. E. J. Lawrence has offered to give $8000 for a library building at Fairfield, Me.

THE British Iron and Steel Institute held its annual meeting at London on May 9th and 10th. Mr. Carnegie announced his intention of founding a scholarship in connection with the Institute for the advancement of research in connection with iron and steel.

THE anniversary meeting of the Royal Geographical Society was held on May 21st. In accordance with the arrangements we have already in part announced, the Founder's medal was awarded to Captain H. H. P. Deasy, for the exploring and survey work which he has accomplished in Central Asia during two expeditions lasting three years altogether. The Patron's medal was awarded to Mr. James McCarthy, for his great services to geographical science in exploring all parts of the kingdom of Siam, for his laborious work during 12 years in collecting materials for a map to form the basis of a survey system, and for his admirable map of Siam just completed. The Murchison award for 1900 was made to M. H. Arçtowski, for his work on the Belgian Antarctic expedition. The Gill memorial for 1900 was awarded to Mr. Vaughan Cornish, for his researches on sea-beaches, sand-dunes, and on wave-forms in water. The Back grant for 1900 was awarded to Mr. Robert Codrington, for his journeys in the region between Lakes Nyasa and Tanganyika, during which he removed a section containing the inscription from the tree under which Livingstone's heart was buried. The Cuthbert Peek grant for 1900 was awarded to Mr. T. J. Alldridge, for his journeys in the interior of Sierra Leone. The president, Sir Clements Markham, said in the course of his address that £30,000 was still required for the Antarctic Expedition, but that the keel of their exploring ship had been lain at Dundee.

THE New York State Museum will conduct during the summer a station on Lake Saranac for the study of aquatic insects. It will be under the direction of Dr. Charles Needham.

THE University of the State of Missouri is to send an entomological expedition into southern Mexico this summer. It will be in charge of Professor J. M. Stedman, head of the Entomological Department, and will have for its object the making of a biological, largely entomological, survey of the region from Vera Cruz on the Gulf, which is in perpetual tropics, to the top of the volcano Popocatepetl, which is far above the perpetual snow line, and down to Acapulco on the Pacific. This will give all the temperature variations from perpetual tropics to perpetual snow, and will allow of the study of life zones under conditions not to be found elsewhere in North America. The collection will become the property of the University, which is to furnish half the expenses, the other half to be borne by Professor Stedman.

M. A. CARLETON, of the Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, is now in Paris installing the exhibit illustrating cereal production in the United States. Early in June Mr. Carleton will visit Russia for the purpose of collecting new varieties of cereals for introduction into the United States.

MR. ALBERT F. WOODS, of the Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, has prepared an extensive paper on a disease of carnations which hitherto has been known under the name 'bacteriosis.' Mr. Woods's studies, which have been carried on for several years, seem to prove conclusively that the disease is due to the punctures of insects, principally aphides, and thrips. For this reason he suggests the name 'stigmonose' for the malady. The paper is illustrated by plates and text figures and will be ready for distribution early in June.

The work on tobacco inaugurated last year by the Division of Vegetable Physiology and Pathology, U. S. Department of Agriculture, is being continued. The work is in charge of Dr. Oscar Loew, and has for its principal object the study of fermentation of the tobacco leaf. Some important results bearing on the changes which take place in the fermentation of the leaf have already been obtained. A paper giving the results of the work in detail will soon be published by the Department.

The second annual meeting of the Astronomical and Astrophysical Society of America (Fourth Conference of Astronomers and Astrophysicists) will be held in conjunction with the meeting of the American Association at Columbia University beginning on June 26th. In addition to papers which may be presented to the Society, arrangements are being made for a series of open discussions upon the following topics: The Eclipse of May 28, 1900; Observations of Eros to be made at the next Opposition; Spectroscopic Determinations of Motion in the Line of Sight.

Announcement is also made of the meeting of the American Forestry Association at the same time and place. It is expected that the Hon. James Wilson, Secretary of Agriculture will preside at the sessions.

The Millinery Merchants' Protective Association which, it is said, controls ninety per cent. of the millinery trade of the country, has proposed to the various Audubon Societies to cease killing or buying any North American birds, except such as are edible and killed in their season, if the societies will undertake not to interfere with the use of these birds or with skins imported from countries not in North America.

The British Ornithologists' Union has passed the following resolution: "That any member of the union directly or indirectly responsible for the destruction of nests, eggs, young or parent birds of any species mentioned below should be visited with the severest censure of the Union and Club." The birds referred to are the chough, golden oriole, hoopoe, osprey, kite, white-tailed eagle, honey buzzard, common buzzard, bittern, and ruff.

A dispatch from Bombay, reports that an unprecedentedly severe epidemic of cholera has broken out in the northern districts of Bombay Presidency, especially in the famine camps, and that the deaths had increased 40 per cent. within three days. In the Kaira District there have been 330 deaths in seven days. The government has made a special grant of £1000 to cremate the dead immediately. In Plaupur State on the first day there was one death, on the second there were eighty-four, and on the third there were upwards of four hundred.

The *Scientific American* states that progress is being made in regard to the introduction of the metric system in Russia. The bill which has been prepared by the Minister of Finance has received the approbation of the State Council, with the understanding that the University and the various scientific societies will give their assistance in the verification of the weights and measures necessary for commercial use. The details have been nearly all decided upon, and will be submitted to the Council in the near future. Since 1896 the metric system has been used by the medical service of the army in the compounding of formulas, this having been made obligatory.

The next meeting of the International Committee of Weights and Measures will be held at Paris on September 10th of the present year.

The committee of the Liverpool School of Tropical Diseases have decided to dispatch at an early date an expedition to the Amazon to investigate yellow fever. This is the third expedition organized by the school within the last nine months. It will probably in the first instance proceed to Baltimore to confer with the yellow fever experts at the Johns Hopkin

University, afterwards going to Para and other places on the South American coast.

THE London correspondent of the N. Y. *Evening Post* reports interesting discoveries of the Hellenic Society in the Palace of Minos at Knossos, near Candia in Crete. On the west of the palace was found a long series of stone galleries with immense decorated oil jars in position and stone receptacles for oil under the floors. A great plaster bull in relief, of artistic excellence for that period, has come to light, and the lower part of a fresco showing a long procession of white-footed ladies in richly embroidered garments and red-footed men semi-nude. In other realistic frescoes of ladies the colors are well preserved. A magnificent set of vases in marble, steatite, and other stones also has been collected, the finest being in the form of a mastiff's head of Parian marble. Clay vases unearthed include a set of perfect vases of the peculiar fantastic and highly colored style which preceded the Mycenæan in Crete. This remarkable ware was only known previously from a few fragments. There are also many remains of a stone age settlement, black geometric pottery, and stone weapons. This completes the series of objects representing the history of Crete from the stone age to about the seventh century B. C. They are said to revolutionize ideas about pre-Hellenic civilization in the Ægean, but the most important fact is the constant evidence of influence from intercourse with the Egypt of the eighteenth and subsequent Pharaonic dynasties.

MR. CHARLES ADAMS, the editor of the *Verulam Review*, an anti-vivisection journal, brought suit against the British Medical Association for damages owing to a statement in regard to him in the *Journal* of the Association. Although Mr. Adams's counsel alleged on his behalf that he was 'an old gentleman and was irritable' the jury did not hesitate to bring in a verdict in favor of the defendants requiring Mr. Adams to pay the costs.

THE director of the U. S. Geological Survey, Dr. Charles D. Walcott, has sent a notice in answer to numerous questions concerning the issue of 'Mineral Resources of the United States, 1898,' to the effect that the following provision was included in an act of Congress approved March 2, 1895: "*Provided*, That hereafter the report of the mineral resources of the United States shall be issued as a part of the report of the Director of the Geological Survey." In conformity with this act of Congress, 'Mineral Resources, 1898,' containing a statement of the production of every mineral in the United States, with its value, where it is found, and where it can be sold, etc., will be published as Part VI. of the 'Twentieth Annual Report of the United States Geological Survey.' The series will continue in succeeding annual reports. Application for the report should be made to members of Congress, who will have a limited number for distribution. The small edition furnished to the office is sufficient only to meet the demands of exchanges and contributors.

FROM the *British Medical Jonrnal* we learn that before the Académie de Médecine in Paris, M. Laveran after presenting an important report on the study of malaria concluded by proposing, first, that the Académie should appoint a committee on malaria; secondly, that it should pass a resolution calling on the Government to send an expedition to Algeria to study in some of the unhealthiest parts of that colony, the relations of mosquitoes to malaria, and the most effectual means of prophylaxis. The proposals were supported by Professor R. Blanchard, who, we understand, has already pressed on the French Government the necessity of founding a French School of Tropical Medicine. He mentioned that he had recently made a catalogue of all the species of *Anopheles* now known, which showed that the geographical distribution of these insects corresponds exactly with that of malaria. M. Laveran's proposals were adopted by the Académie. A committee for the study of malaria was appointed, consisting of MM. Kelsch, Laveran, Blanchard, Railliet and Vallin.

UNIVERSITY AND EDUCATIONAL NEWS.

MESSRS. SAMUEL CUPPLES and Robert S. Brookings have each given to Washington University one-half of the total capital stock of the St. Louis Terminal Cupples Station and Property Company, which company owns the so-called 'Cupples Station.' The annual income from this gift to the University will be from $120,000 to $130,000 per year. The gift is to form a permanent endowment fund, the interest of which is to be expended by the Board of Directors in any way which it sees fit.

BY the will of the late Jonas G. Clark of Worcester, Mass., who founded Clark University in 1889, the entire estate is left to the university, providing the people of Worcester raise a fund of $500,000. If the sum of $250,000 is raised, he bequeaths $500,000. If $500,000 is raised, he bequeaths $1,000,000 and makes the university his residuary legatee. He also leaves $100,000 for the university library and $100,000 for a department of art.

DR. D. K. PEARSONS has offered $50,000 to Carleton College, Northfield, Minn., on condition that the college authorities raise $100,000 before Jan. 1, 1901.

THE late Edward Wheelwright has left his estate, after the death of his widow, to be divided equally between Harvard University and the Boston Museum of Fine Arts.

THE collection of water colors belonging to the late Professor O. C. Marsh, being part of the estate left by him to Yale University, have been sold for about $500. They are said to have cost over $10,000.

BY the will of Henry M. Curry the Western University of Pennsylvania receives $10,000 for scholarships.

THE University of Pennsylvania has received $20,000 each, from Mr. J. D. Lippencott and Mr. J. G. Carruth.

THE University of Michigan has followed the example recently set by Harvard, Cornell and Columbia Universities by making its entrance requirements more flexible and the same for the several degrees it still offers in its literary department. According to the new schedule, fifteen units are required for admission, a unit being one subject pursued for not less than four periods a week through a school year. The fifteen units must include three units of English, three of mathematics, and one of physics. The remaining eight units are to be selected from the following list, but they must include two units of either Latin, French or German. The figures indicate the number of units for which each subject may be counted: Greek, 2; Latin, 2 or 4; German, 2 or 4; English literature, 1; history, 1, 2 or 3; chemistry, 1; botany, 1; zoology, 1; biology (a half year each of botany and zoology), 1; physiography, 1.

DR. FRANK MORLEY, for the past thirteen years professor of mathematics in Haverford College, has accepted a call from Johns Hopkins University. Dr. Thomas Craig has resigned the professorship of mathematics in this University.

PROFESSOR M. C. WHITE, who has for thirty-three years held the chair of pathology in the Medical School of Yale University, has become professor emeritus and is succeeded by Professor Charles J. Bartlett.

JAMES M. TOUMEY, professor of biology in the University of Arizona and director of the Agricultural Experiment Station at Tucson, has been elected assistant professor of forestry at Yale University.

DR. CHARLES A. ELWOOD, instructor in the University of Nebraska, has been elected professor of sociology in the University of Missouri. He is a graduate of Cornell University and the University of Chicago.

THE instructors in the summer school of Harvard University include the following: In psychology, Dr. MacDougall; in education, Professor Hanus and Mr. Norton; in theory of design, Mr. Ross, Mr. Clark, and Mr. Swan; in mathematics, Dr. Smith, Mr. Love, Mr. Ashton, and Dr. Campbell; in astronomy, Mr. Reed; in engineering, Mr. Turner; in shop-work, Professor Burke; in physics, Professor Sabine, Mr. McElfresh, and Mr. Collins; in chemistry, Dr. Torrey, Mr. Wheeler, and Mr. Black; in botany, Mr. Olive and Mr. King; in geology, Professor Shaler, Professor Brigham, Mr. Woodworth, and Mr. Woodman; in geography, Professor Davis and Mr. Burr; in mineralogy, Dr. Eakle; in physical training, Dr. Sargent.

MISS CORA J. BECKWITH, assistant in the zoological laboratory of the University of Michigan, has been appointed assistant instructor in zoology at Vassar College for the year 1900 1901.

SCIENCE

FRIDAY, JUNE 15, 1900.

CONTENTS:

MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE FOR 1901.

THE Congressional Act making appropriations for the Department of Agriculture for the fiscal year ending June 30, 1901, shows an increase of more than $280,000 over the appropriations for the preceding year. The total amount is $4,023,500 of which $720,000 is for the experiment stations in the 48 States and Territories, $12,000 for the stations in Alaska, $10,000 for a new station in Hawaii, 'including the erection of buildings, the printing (in the Hawaiian Islands), illustration and distribution of reports and bulletins, and all other expenses essential to the maintenance of said station,' and $5000 for an investigation and report to Congress on the Agricultural resources and capabilities of Porto Rico, "with special reference to the selection of locations for agricultural experiment stations and the determination of the character and extent of agricultural experiments immediately demanded by the conditions of agriculture in that Island; to prepare, print publish and distribute in Porto Rico, circulars of inquiry and bulletins of information in the English and Spanish languages."

The sum of $10,000 was appropriated for the purpose of commencing the necessary improvements for the establishment and maintenance of a general experimental farm and agricultural station on the Arlington Estate, on the Virginia shore of the Potomac.

The appropriation for the Office of Experiment Stations is $33,000, and the special investigations in charge of this Office are provided for as follows: Nutrition of man $17,500, an increase of $2500; and Irrigation $50,000, an increase of $15,000.

The largest increases in the appropriations are for the Bureau of Animal Industry, Divisions of Forestry and Seeds, and the Weather Bureau. The appropriation for the Bureau of Animal Industry is $1,078, 830, an increase of $46,800. The appropriation for Animal Quarantine Stations is increased from $12,000 to $50,000. The Division of Forestry receives an increase of $40,000, $5000 of which may be used to investigate the forest conditions of the southern Appalachian Mountain regions of western North Carolina and adjacent States. The appropriation for the Division of Seeds is increased from $130,000 to $170,000. The increased appropriation for the purchase of seed was due in a large measure to a petition of some 225 members of the House of Representatives. The total appropriation for the Weather Bureau is $1,058,320, an increase of $35,838. The work of the Bureau is to be extended to the Hawaiian Islands. The salary of the Chief of the Bureau is increased to $5000.

In addition to the lines of work previously undertaken the Division of Chemistry is charged with new duties, as follows:

"To investigate the cause of the deterioration in the gluten content of wheat on the Pacific Coast and in other parts of the country. To study the methods for increasing the content of valuable food constituents in wheat and other cereals. * * *

"To investigate the character of proposed food preservatives and coloring matters. To determine their relations to digestion and to health and to establish the principles which should guide their use.

"To investigate the character of the chemical and physical tests which are applied to American food products in foreign countries, and to inspect, before shipment, when desired by the shippers or owners of these food products, American food products intended for countries where chemical and physical tests are required before said food products are allowed to be sold in the countries mentioned." The appropriation for this Division is $35,600.

The appropriation for the Division of Agrostology was increased $5000 making its total appropriation $25,100. The work of the Division is enlarged to include investigations as to the best methods for exterminating Johnson and other noxious and destructive grasses and co-operative experiments to be carried on in connection with the agricultural experiment stations "in establishing and maintaining experimental grass stations for determining the best methods of caring for and improving meadows and grazing lands, the use of different grasses and forage plants and their adaptability to various soils and climates, the best native and foreign species for reclaiming overstocked ranges and pastures, for renovating worn out lands, for binding drifting sands and washed lands, and for turfing lawns and pleasure grounds."

The Division of Entomology receives $33,200, an increase of $2500. A special investigation is ordered as to 'the ravages of the codling moth with a view to ascertaining the best method of its extermination.'

The sum of $34,500 is appropriated for the Division of Vegetable Physiology and Pathology. The policy of Secretary Wilson in employing the graduates of agricultural colleges as scientific aids has received the endorsement of Congress by an express provision for the employment of such aids in this Division.

Of the $31,300 appropriated for the Division of Soils, $10,000 may be used 'for the purpose of demonstrating the practical value of underdrainage and other methods of reclaiming alkali lands.' The appropriation for this Division is $5000 greater than last year.

The fund used in making investigations as to the adaptability of the South for profitable tea culture was increased from $1000 to $5000.

The fund provided for the Division of Publications is $130,020, an increase of $28,360. The amount set aside for the printing of Farmers' Bulletins is $22,500 greater than last year. Four-fifths of the Farmers' Bulletins are to be sent out by members of Congress instead of two-thirds as formerly.

Other items of the appropriation act are as follows: Biological Survey $30,300, an increase of $2740; Division of Botany $43,080, an increase of $14,280; Division of Pomology $18,400; Public Road Inquiry $14,000, an increase of $6000; Division of Statistics $146,160; Library $14,000; and Museum $2260.

The item of $200,000 for a new laboratory which was taken out of the Agricultural Bill and put with those for other public buildings in the Sundry Civil Bill failed to pass.

VARIATION AND SOME PHENOMENA CONNECTED WITH REPRODUCTION AND SEX.

II.

EFFECT OF CHANGED CONDITIONS IN ASEXUAL REPRODUCTION.

THIS brings us to the consideration of the question reserved: Are genetic variations ever found in asexual reproduction?

If the views expressed in the earlier part of this address are correct it would seem to follow that genetic variations are variations in the actual constitution, and are inseparably connected with the act of conjugation. The act of conjugation gives us a new constitution, a new individuality, and it is the characters of this new individual in so far as they differ from the characters of the parents which constitute what we have called genetic variations. According to this the answer to our question would be that genetic variations cannot occur in asexual reproduction, and that if any indefinite variability recalling genetic variability makes its appearance* it must be part of the genetic variability and directly traceable to the zygote from which the asexual generations started.

But if genetic variability is not found in asexual reproduction the question still remains, can the other kinds of variations—namely, those due to the direct action of external forces upon the organism—be transmitted in asexual reproduction? Now we have already seen that the effect of external agencies acting upon the organism must be regarded under two heads, according as to whether the reproductive organs are or are not affected. If the reproductive organs are not affected, then variations caused by the impact of external forces will

* Weismann, *On Heredity*, vol. ii, English edition, p. 161. Warren, E. 'Observation on Heredity in Parthenogenesis,' *Proc. Roy. Soc.* 65, 1899, p. 154. These are the only observations I know of on this subject. They tend to show the presence of a slight variability, but they are not entirely satisfactory. In connection with this matter I may refer to Weismann's view that *Cypris reptans*, the species upon which his observations were made, reproduces entirely by parthenogenesis, and has lost the power of sexual reproduction. This view is based on the fact that he has bred forty consecutive parthenogenetic generations and has never seen a male. As Weismann bases some important conclusions on this view, with regard to the importance of conjugation in rejuvenescence of organisms, I may point out that the fact that he has bred forty successive generations and has never seen a male cannot be regarded as conclusive evidence that males never appear. We know of many cases in which reproduction can continue for more than forty generations without the intervention of conjugation, *e. g.*, ciliated infusoria, many plants, and of other species of crustacea in which the male is very rare and only appears after long intervals.

not be transmitted; if, on the other hand, they are affected, the next generation will show the effect. We have further seen that in the case of sexual reproduction a modification of the reproductive organs will, because of the intervention of conjugation, appear as an increase in genetic variability only. How will the matter stand in the case of asexual reproduction? First, with regard to modifications which do not affect the reproductive system—they, as in sexual reproduction, will not be transmitted. Secondly, as regards modifications which do affect the reproductive organs—they will be transmitted, *i. e.*, they will affect the next generation; and the question arises, how will they be transmitted? For here we have the opportunity wanting in the case of sexual reproduction of studying the transmission of modifications of the reproductive system without the complications introduced by the act of conjugation.

In considering this matter, it must be remembered that the reproductive organs are with regard to external influences exactly as any other organ. They can be modified either directly or indirectly, though they are in animals often less liable to direct modification by reason of their internal position.* These modifications may, as in the case of other organs, be obvious to the eye of the observer, or they may be so slight as only to be detected by an alteration of function. Now, in the case of the reproductive organs this alteration of function will show itself in the individuals of the next generation (if not before) which proceed directly and without any complication from the affected tissue. How will these individuals be affected? Will they all be affected in the same kind of way or will they be affected in different ways? Finally, will the modification last their lives only, or will it continue into subsequent asexually produced generations?

* How far the abnormal position of the testes of mammalia may receive its explanation in this connection is a question worthy of consideration.

Let us endeavor to answer these questions:

(1) How will the offspring be affected? That will depend entirely upon how the reproductive organ was affected. Will the modification in the offspring have any adaptive relation whatever to the external cause? Now here we have a capital opportunity, an opportunity not afforded at all by sexual reproduction, of examining by experiment and observation the Lamarckian position. My own opinion is that there will be no relation of an adaptive kind between the external cause and the modification of the offspring. For instance, let us imagine, as an experiment, that a number of parthenogenetically reproducing organisms are submitted to a temperature lower than that at which they are accustomed to live. Let us suppose that the cold affects their reproductive organs and produces a modification of the offspring. Will the modification be in the direction of enabling the offspring to flourish in a lower temperature than the parent? My own opinion, as I have said, is that there will probably be no such tendency in the offspring, if all possibility of selection be excluded. But that is only an opinion. The question is unsettled, and must remain unsettled until it is tested upon asexually reproducing organisms.

(2) Will they all be affected in the same kind of way? Yes, presumably they will. I arrive at this conclusion, not by experiment, but by reasoning from analogy. In the case of other organs of the body, the same external cause produces in all individuals acted upon, roughly speaking, the same kind of effect, *e. g.*, action of sun upon skin, effect of transplanting maize, Porto Santo rabbits, etc. The question, however, cannot be settled in this way. It requires an experimental answer.

(3) Will the modification last beyond

the life of the individuals produced by the affected reproductive organ? I can give no answer to this question. We have no data upon which to form a judgment. We cannot say whether it is possible permanently to modify the constitution of an organism in this way, or whether, however strong the cause may be, consistently of course with the non-destruction of life, the effects will gradually die away—it may be in one, it may be in two or more generations. There are cases known which might assist in settling these questions, but I must leave to another opportunity the task of examining them. I refer to such cases as *Artemia salina*, various cases of bud variation which cannot be included under the head of growth variation.

SENILE DECAY AND REJUVENESCENCE OF ORGANISMS.

Another question, also of the utmost importance, confronts us at this point. As is well known, organisms are liable to wear and tear, sooner or later some part or parts essential to the maintenance of the vital functions wear out and are not renewed by the reparative processes which are supposed to be continually taking place in the organism. This constitutes what we call senile decay, and leads to the death of the organism. As a good example of the kind of cause of senile decay, we may mention the wearing out of the teeth, which in mammals at any rate are not replaced; the wearing out of the elastic tissue of the arterial wall, which is probably not replaced. There is no reason to suppose that the reparative process of any organism is sufficiently complete to prevent senile decay. There is probably always some part or parts which cannot be renewed, even in the simplest organisms. Maupas has shown that this holds for the ciliated Infusoria, and he has also shown how the renewal of life, which of course must be effected if the species is to continue, is brought about. He has shown that it is brought about by conjugation, during which process the organism may be said to be put into the melting-pot and reconstituted. For instance, many of the parts of the conjugating individuals are renewed, including the whole nuclear apparatus, which there is every reason to believe is of the greatest importance to living matter.

On reconsidering the life of the Metazoa in light of the facts established by Maupas for the Infusoria, we see that all Metazoa are in a continual state of fission, as are the ciliated Infusoria. They are continually dividing into two unequal parts, one of which we call the parent and the other the gamete. The parent Metazoon must eventually die; it cannot be put into the melting-pot; its parts cannot be completely renovated. The gamete can be put into the melting-pot of conjugation, and give rise to an entirely reconstituted organism, with all the parts and organs brand new and able to last for a certain time, which is the length of life of the individual of the species.

Is there any other way than that of conjugation by which an organism can acquire a complete renewal of its organs? Is the renewal furnished by the development of all the parts afresh which takes place in a parthenogenetic ovum such a complete renewal? This question cannot now be certainly answered, but the balance of evidence is in favor of a negative answer. And this view of the matter is borne out by a consideration of the facts of the case. In all cases of conjugation which have been thoroughly investigated, the nuclear apparatus is completely renewed. It would appear indeed as though the real explanation of the uninuclear character of the Metazoon gamete is to be sought in the necessity of getting the nuclear apparatus into the simplest possible form for renewal. Now in the development of a parthenogenetic ovum the ordinary process of renewal of the nucleus is often in partial abeyance. As a rule it only divides once instead of twice, and there is, of course, no reinforcement by nuclear fusion. It is, of course, possible that the reinforcement by nuclear fusion which occurs in conjugation may have a different explanation from the nuclear reconstitution which takes place in the formation of polar bodies and similar structures. On the other hand, it may all be part of the same process. We cannot tell. So that we are unable to answer the question whether for complete rejuvenescence a new formation of all parts of the organism is sufficient, or whether a reconstitution of the nuclear apparatus of the kind which takes place in the maturation of the Metazoon ovum and the division of the micro-nucleus of Paramecium is also required ; or finally, whether in addition to the latter phenomenon a reinforcement and reconstitution by fusing with another nucleus is also necessary for that complete rejuvenescence which enables an organism to begin the life cycle again and to pass through it completely.

With regard to buds in plants there is reason to believe that they share in the growing old of the parent. That is to say, if we suppose the average life of the individual to be 100 years, a bud removed at 50 will be 50 years of age, and only be able to live on the graft for 50 more years.

HEREDITY.

Having now spoken at some length of the phenomenon of variation, I must proceed to consider from the same general point of view the phenomenon of heredity.

As we have seen, in asexual reproduction heredity appears, as a general rule, if not always, to be complete. The offspring do not merely present resemblances to the parent—they are identical with it. And this fact does not appear to be astonishing when we consider the real nature of the process. Asexual reproduction consists in the separation off of a portion of the parent, which, like the parent, is endowed with the power of growth. In virtue of this property it will assume, if it does not already possess it, and if the conditions are approximately similar, the exact form of the parent. It is a portion of the parent; it is endowed with the same property of growth; the wonder would be if it assumed any other form than that of the parent. Indeed, it is doubtful if the word heredity would ever have been invented if the only form of increase of organisms was the asexual one, because there being no variation to contrast with it, it would not have struck us as a quality needing a name, any more than we have a name for that property of the number two which causes it to make four when duplicated.

The need for the word heredity only becomes apparent when we consider that other form of reproduction in which the real act of reproduction is associated with the act of conjugation. Looking at reproduction from a broad point of view, we may sum up the difference between the two kinds, the sexual and the asexual, by saying that whereas the essence of sexual reproduction is the formation of a new individuality, asexual reproduction merely consists in increasing the number of one kind of individual. From this point of view sexual reproduction is better termed the creation of a new individuality, for that, and not the increase in the number of individuals, is its real result. Inasmuch as conjugation of two organisms is the essential feature of sexual reproduction, it would appear that the number of individuals would be actually diminished as a result of it; and this does really happen, though in a masked manner, for we are not in the habit of looking upon the spermatozoon and ovum as individuals, though it is absurd not to do so, as they contain latent all the properties of the species, and are sometimes able to manifest these properties (parthenogenetic ova) without conjugating. In some of the lower organisms the fact that conjugation does not result in an increase of the number of individuals, but only in the production of a new individuality, is quite apparent, for in them two of the ordinary individuals of the species fuse to form one (many Protozoa).

So that sexual reproduction gives us a new individuality which can spread to almost any extent by asexual reproduction. This asexual reproduction gives us a group of organisms which is quite different from a group of organisms produced by sexual reproduction. Whereas the latter groups constitute what we call species, the former group has, so far as I know, no special name, unless it be variety; but variety is not a satisfactory name, for it has been used in another sense by systematizers.

Heredity, then, is really applicable only to the appearance in a zygote of some of the properties of the gametes. A zygote has this property of one of the precedent gametes, and that property of the other, in virtue of the operation of what we call heredity; it has a third property possessed by neither of the precedent gametes in virtue of the action of variation, the nature of which we have already examined. It is impossible to say which property of a gamete will be inherited, and it is impossible to predict what odd property will result from the combination of the properties of the two gametes. Of one thing only are we certain, that they are never the same in zygotes formed by gametes produced in immediate succession from the same parent.

We may thus regard the activities of the zygote as the resultant of the dashing together of the activities of the gametes.

Conjugation, then, is a process of the utmost importance in Biology; it provides the mechanism by which organisms are able to vary, independently of the conditions in which they live. It lies, therefore, at the very root of the evolution problem; the power of combining to form a zygote is one of the fundamental properties of living matter.

SPECIES.

Now let us consider one of the effects of this property upon organisms. The effect to which I refer is the division of animals into groups called species. Species are groups of organisms, the gametes of which are able to conjugate and produce normal zygotes. Now in Nature there appear to be many causes which prevent gametes from conjugating. First and most important of all is some physical incompatibility of the living matter which prevents that harmonious blending of the two gametes which is essential for the formation of a normal zygote. Very little is known as to the real nature of this incompatibility; in fact it is hardly an exaggeration to say that nothing is known. It may be that there is actual repulsion between the gametes, or it may be in some cases, at least, that the gametes are able to fuse, but not to undergo that intimate blending which is necessary for the production of a perfect zygote. In some cases we know that something like this happens; for instance, a blend can be obtained between the horse and the ass, but it is not a perfect blend, the product or zygote being imperfect in one most important particular—namely, reproductive power.

A second cause which prevents conjugation is a purely mechanical one—viz, some obstacle which prevents the two gametes from coming together. As an instance of this I may refer to those cases amongst plants in which conjugation is impossible because the pollen tube is not long enough to reach the ovule. In yet other cases conjugation is impossible because the organisms are isolated from one another either geographically or in consequence of their habits. There are probably many causes which prevent conjugation, but, whatever they may be, the effect of them is to break up organisms into specific groups, the gametes of which do normally conjugate with one another.

In many cases, no doubt, the gametes of organisms which are kept apart in Nature by mechanical barriers will conjugate fully if brought together. But in the great majority of cases it is probable that no amount of proximity will bring about complete conjugation. There is physical incompatibility. Here is a fruitful opening for investigation. Observations are urgently needed as to the real nature of this incompatibility.

IMPORTANCE OF THE STUDY OF VARIATION.

Another and most important effect of conjugation is, as we have seen, the much-spoken-of constitutional or genetic variations. They are, as we have already insisted, of the utmost importance to the evolutionist. Evolution would have been impossible without them, for it is made up of their summation. It becomes, therefore, desirable to find out to what extent a species is capable of varying. This can only be done, as Mr. Bateson has pointed out, by recording all variations found. Mr. Bateson, in his work already referred to, has carried this out, and has shown the way to a collection of these most important data. In order to carry it further, I would suggest that the collection be made not only for structure, but also for function. This has been done largely for the nervous functions by psychologists and naturalists who pay special attention to the instincts of animals; but we want a similar collection for other functions. For instance, the variations in the phenomena of heat and menstruation, and of rut amongst mammals, and so on. To do this is really only to apply the methods of comparative anatomy and comparative physiology to the members of a species, as they have already been applied to the different species and larger groups of the animal kingdom. Such investigations cannot fail to be of the greatest interest. Indeed, when we have learnt the normal habits and structure of a species, what more interesting study can there be than the study of the possibilities of variation contained within it? Then when we know the limits of variability of any given specific group, we proceed to try if we can by selective breeding or alteration of the conditions of life alter the variability, and perhaps call into existence a kind of variation quite different in character from that previously obtained as characteristic of the species.

THE EVOLUTION OF HEREDITY AND THE ORIGIN OF VARIATION.

These remarks bring me to the consideration of a point to which I am anxious to call your attention, and which is an important aspect of our subject. Has the variability of organisms ever been different from what it is now? Has or has not evolution had its influence upon the property of organisms as it is supposed to have had upon their other properties? There is only one possible answer to this question. Undoubtedly the variability of organisms must have altered with the progress of evolution. It would be absurd to suppose that organisms have remained constant in this respect while they have undergone alteration in all their other properties. If the variability of organisms has altered, it becomes necessary to inquire in what direction has it altered? Has the alteration been one of diminution, or has it been one of increase? Of course, it is possible that there has been no general alteration in extent with the course of evolution, and that the alteration, on the whole, has been one of quality only. But passing over this third possibility, let us consider for the moment which of the two first named alternatives is likely to have occurred.

According to the Darwinian theory of evolution, one of the most important factors in determining the modification of organisms has been natural selection. Selection acts by preserving certain favorable variations, and allowing others less favorable to be killed off in the struggle for existence. It thus will come about that certain variations will be gradually eliminated. Meanwhile the variations of the selected organisms will themselves be submitted to selection, and certain of these will be in their turn eliminated. In this way a group of organisms becomes more and more closely adapted to its surroundings; and unless new variations make their appearance as the old unfavorable ones are eliminated, the variability of the species will diminish as the result of selection. Is it likely that new variations will appear in the manner suggested? To answer this question we must turn to the results obtained by human agency in the selective breeding of animals. The experience of breeders is that continued selection tends to produce a greater and greater purity of stock, characterized by small variability, so that if the selective breeding is carried too far, variation almost entirely ceases, and there is little opportunity left for the exercise of the breeder's art. When this condition has been arrived at, he is obliged, if he wants to produce any further modifications of his animals, to introduce new blood—*i. e.*, to bring in an individual which has either been bred to a different standard, or one in which the variability has not been so completely extinguished.

It would thus appear, and I think we are justified in holding this view, at any rate provisionally, that the result of continued selection will be to diminish the variability of a species; and if carried far enough, to produce a race with so little variability, and so closely adapted to its surroundings, that the slightest alteration in the conditions of life will cause extinction.*

If selection tends to diminish the variability of a species, then it clearly follows that as selection has been by hypothesis the most important means of modifying organisms, variation must have been much greater in past times than it is now. In fact it must have been progressively greater the farther we go back from the present time.

The argument which I have just laid before you points, if carried to its logical conclusion—and I see no reason why it should not be so carried—to the view that at the first origin of life upon the earth the variability of living matter consequent upon the act of conjugation must have been of enormous range; in other words, it points to the view that heredity was a much less important phenomenon than it is at present. Following out the same train of thought, we are inevitably driven to the conclusion that one of the most important results of the evolutionary change has been the gradual increase and perfection of heredity as a function of organisms and a gradual elimination of variability.

This view, if it can be established, is of the utmost importance to our theoretical conception of evolution, because it enables us to bring our requirements as to time within the limits granted by the physicists.

*The expression extinction of species seems to be used in two senses, which are generally confused. Firstly, a species may become modified so that the form with which we are familiar gradually gives place to one or more forms which have been gradually produced by its modification. That is to say, a character or series of characters becomes gradually modified or lost in successive generations. This is not really extinction, but development. Secondly, a species may gradually lose its variability, and become fixed in character. If the conditions then change, it is unable to adapt itself to them, and becomes truly extinct. In this case it leaves no descendants. We have to do with death, and not with devel pment.

If variation was markedly greater in the early periods of the existence of living matter, it is clear that it would have been possible for evolutionary change to have been effected much more rapidly than at present—especially when we remember that the world was then comparatively unoccupied by organisms, and that with the change of conditions consequent on the cooling and differentiation of the earth's surface, new places suitable for organic life were continually being formed. It will be observed that the conclusion we have now reached, viz, that variation was much greater near the dawn of life than it is now, and heredity a correspondingly less important phenomenon, is a deduction from the selection theory. It becomes, therefore, of some interest to inquire whether a suggestion obtained by a perfectly legitimate mode of reasoning receives any independent confirmation from other sources. The first source of facts to which we turn for such confirmation must obviously be paleontology. But paleontology unfortunately affords us no help. The facts of this science are too meagre to be of any use. Indeed, they are wanting altogether for the period which most immediately concerns us—namely, the period when the existing forms of life were established. This took place in the prefossiliferous period, for in the earliest fossiliferous rocks examples of almost all existing groups of animals are met with.

But although paleontology affords us no assistance, there is one class of facts which, when closely scrutinized, do lend some countenance to the view that when evolutionary change was at its greatest activity, *i. e.*, when the existing forms of life were being established, variation was considerably greater than it is at the present day.

But as this address has already exceeded all reasonable limits, and as the question which we are now approaching is one of very great complexity and difficulty, I am reluctantly compelled to defer the full consideration and treatment of it to another occasion. I can only hope that the far-reaching importance of my subject and the interest of it may to some extent atone for the great length which this address has attained.

Adam Sedgwick.

Cambridge University.

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*THE PROTEIDS OF LIVING MATTER.**

Of all the phenomena of nature vital phenomena have always appeared to the human mind the most complicated and intricate, so much so that even many scientific men have ascribed them to an inexplorable cause—the so-called vital force. This 'vitalism' is adhered to by many even to-day. In scrutinizing the various vital phenomena we observe, however, a great difference in the degree of complexity. There are on the one hand actions of an admittedly purely chemical, physical, and mechanical nature; and on the other those of organization, genetic differentiation, and of irritability on which differences of opinion still exist. The former appear of relatively simple character compared with the latter, which seem to offer difficulties of explanation insurmountable for science in its present state of development.

Protoplasm even of the simplest cells represents a highly complicated machinery. The organization corresponds to the construction of a machine, while its motive power consists in various forms of energy. Hence, two principal questions arise: (1) How is the machinery constructed? (2) What is the nature of the primary energy moving the machinery? The latter question is of a simpler kind than the former. We

* A paper read before the joint meeting of the Biological and Chemical Societies of Washington, May 5, 1900.

know that cells produce heat by the process of respiration (some of the lowest forms of fungi also by fermentative action) and that this heat energy is necessary for carrying on the various functions of life, for which purpose it can be transformed into chemical, electrical and mechanical energy in the cells. But how are the cells enabled to bring on the active oxidation phenomena that characterize the respiration process, and by what special contrivance can the heat energy thereby produced be converted into other forms of energy?

The conception of the nature of living protoplasm has changed with the progress of time. Formerly and by some authors even at the present time, it was defined as a changing mixture of different substances and all compounds found in the protoplasm were considered indispensable and intrinsic parts of it. Compare for instance, the publications of Reinke on the protoplasm of *Æthalium septicum.* Recently also Verworn has returned to this old conception.

But such a view cannot be logically entertained when we see that a certain protoplasm does continuously the same kind of work like a mechanism of a fixed structure. This mechanism consists here in a specific structure built up of easily changeable proteins requiring a certain amount of water and mineral salts. The amount of imbedded material, however, may continuously change. This material consists either of thermogens, as fat and sugar, or of mere by-products of metabolism which are soon excreted after their formation, either to the outside or into the vacuole.

What kind of work will result? it depends upon the configuration* and the specific chemical structure of these protein molecules on the one hand, and upon the specific construction of the machinery on the other. Thus, the protoplasts of the various vegetable and animal glands resemble just as many different chemical laboratories; the protoplasm of the muscular fibers severs molar motions; that of the nerves is especially adapted to conduct impressions by irritation to considerable distances. But the most complicated differentiation governs the structures of the nuclei of the generative cells, the most intricate laws rule the genetic differentiations in the development of an organism.*

* The relative position of atoms in space.

From the chemical standpoint our first inquiry is directed, as already mentioned, to the question: *What causes the respiration-process of the cells?* What enables the proteins to cause the active oxidations of fat and glucose as long as the cells are alive, and why do these oxidations cease as soon as the cells are killed? Oxidation is a purely chemical phenomenon; hence, this question is of a plain chemical nature. Some might claim that by the death of the cells the organization is destroyed and this is the cause of the stoppage of the oxidation. But this view cannot be upheld, since even the most complicated machinery cannot produce work without the impelling energy. There must also be a certain amount of energy at the bottom of the respiration itself, there must be some energy for kindling the fire of the locomotive. What is this energy that leads to respiration? There remains no other answer than this: *It is chemical energy caused by the specific nature of the proteids of the living protoplasm which nature changes in the process of dying.*† Nu-

* Nucleo proteids form the framework of the nucleus and of the cytoplasm and may exist in innumerable isomeric forms, of which the stereo-isomeric forms probably are of great importance as regards the differences between species. The word *proteid* is used here to designate the complicated compounds of proteins, such as nucleins, hæmoglobin, mucin, while the word *protein* comprises all kinds of albuminous matter in a general sense.

† A chemical change in the proteins of the living matter in the dying process was assumed as early as 1837 by John Fletcher and again in 1875 by E. Pflüger. But even at the present day many physi-

merous compounds are known which very easily undergo a chemical change; modern chemistry defines them as *labile* (unstable) compounds. Sometimes influences of a very subtle nature suffice to cause migration of the atoms in labile position to a more stable position whereby an isomeric and more stable product results.

I have repeatedly pointed out that we must distinguish between potentially labile and kinetically labile compounds; in other words, between static labile and dynamic labile.* To the former belong for example, the explosive organic compounds, as nitroglycerole or certain diazo compounds, to the latter aldehydes and ketones.† While the former are destroyed by chemical changes either totally or partially, the latter furnish numerous derivatives with great readiness, or change easily by atomic migration or by polymerization into isomeric or polymeric compounds. Many highly interesting cases of chemical change by atomic migration within labile molecules are known, but reference needs here be made only to one of the simpler instances—the change of ammonium cyanate into urea which is accomplished by merely heating the aqueous solution of the former.

$$\underset{\text{Ammonium cyanate.}}{O:C:N.NH_4} \quad \text{becomes} \quad \underset{\text{Urea.}}{O:C\genfrac{}{}{0pt}{}{.NH_2}{.NH_2}}.$$

This transformation is also of interest from another point of view, as being the first synthesis of an organic substance, accomplished by Woehler in 1828.

ologists adhere to the old opinion of chemical identity of proteins in the living and dead protoplasm.

* The potential chemical energy in this discussion does not refer to the energetic relation of the compound to others, as in combustion, but to the intramolecular relation between the atoms of the compound itself. We may distinguish this as intramolecular potential chemical energy.

† The enzymes also belong to the dynamically labile compounds, as I have pointed out in SCIENCE, December, 1899.

The analogy of living matter to dynamically labile compounds is also elucidated by the action of many poisons. Prussic acid, diamidogen, hydroxylamine, have in moderate dilutions at the ordinary temperature no action whatever on dead protoplasm or on the ordinary proteins, while they change living protoplasm very easily to dead protoplasm, a change induced by a chemical attack, labile compounds being more easily attacked by chemical agents than stable ones.*

The principle of chemical lability has not yet been the object of close investigation even by chemists, while physiologists have ignored it altogether, and this may be the reason that the necessity for assuming a chemical difference between the proteins of the living and of the dead protoplasm has not found due consideration, although this distinction is absolutely necessary for comprehending the *chemical* properties of living protoplasm. The free chemical energy due to the labile character of the proteids in the living protoplasm leads to respiration and since this energy cannot be produced after those labile proteins have changed to stable ones, respiration must cease also at the moment of death. The heat produced by respiration increases still further the oscillations of the labile atoms in the plasma proteins, in other words, it increases the charge of chemical energy, and the most complicated chemical work can now be carried out, the specific construction of a protoplast determining the kind and direction of the work. The maintenance of the respiration process is just as little due to a con-

* A systematic toxicological review shows us among other things that all compounds acting upon aldehydes and all that easily attack labile amido-groups are poisonous for all kinds of living protoplasm which fact led me to infer that the lability of the plasma proteids is caused by the presence of aldehyde and amido-groups within the same molecules. Compare: A natural system of poisonous actions, Munich, E. Wolff, publisher.

tinuous self-decomposition and regeneration of protoplasm, as Pflüger and Detmer assume, as to a previous activifying of oxygen as various other authors had supposed; but, as I have repeatedly pointed out, to an '*activifying of the thermogens*' by a charge with chemical energy from the protoplasm. An activified oxygen (ozone) or also hydrogen peroxid would kill the protoplasm sooner than it would burn up fat and sugar to carbonic acid and water. Indeed, nature has provided every living cell with a special enzyme which decomposes rapidly any trace of hydrogen peroxid that might make its appearance as a by-product in the active course of the cellular respiration.†

Other functions than chemical ones, as for instance the intricate phenomena of karyokinesis or the remarkable differentiation into ectoderm, entoderm, and mesoderm, or the differentiation of nervous fibers, although they are still very mysterious, also depend primarily upon the labile nature of the proteins. Not the slightest advance towards an understanding of these phenomena can be expected when this is disregarded.

The *primum movens* in the living protoplasm must be defined as a mode of motion of labile atoms in the plasma proteins; that is, as a *special case of chemical energy*. Living protoplasm has often been compared to a watch and dead protoplasm to a watch whose machinery has been destroyed by crushing, but this comparison is not a proper analogy, for, while the *chemical* character of the watch material remains unchanged after pulverizing, that of the dying protoplasm does not, but it undergoes a *chemical* change.

These deductions must necessarily lead to the further question: Is there any evidence of labile proteins existing before the organization into living matter is accomplished? Is any not yet organized forerunner of living protoplasm found in cells? Investigations of Dr. Th. Bokorny and myself carried on for a number of years have demonstrated beyond a doubt that there indeed occurs in many plants a reserve protein matter of highly labile nature, different from all other reserve proteins. It undergoes a great change under the same conditions that cause the death of the protoplasm itself, although more slowly. It seems logical to conceive this as the material which, by being converted into organized nucleo proteids, forms the living matter. The ordinary proteins must be brought first into the labile easily changeable condition before they can serve this purpose. We designated that labile reserve protein as active albumin or proto-protein, in contradistinction to the passive reserve proteins.

This peculiar, easily changeable body is met with in certain groups of plants very frequently, as in Julifloræ, Cystofloræ, Æsculineæ, Saxifragineæ, Myrtifloræ, and Rosifloræ, while in others rarely, as in Compositæ, Labiatæ, Leguminosæ, and Gramineæ, in fungi and in algæ. *Spirogyra* forms an exception with the algæ, inasmuch as this special group contains often very large quantities of the labile reserve protein. The widespread occurrence of this substance may be inferred from the fact that of 250 species examined by Th. Bokorny, G. Daikuhara, and myself, fully 120 were found to contain it in one part or other.

Of special objects rich in this proto-protein may be enumerated: Leaves of *Prunus*, *Rosa*, *Quercus*, *Alnus*, *Mimosa*, *Pæonia*, *Saxifraga*, *Sedum*, and *Cephalotus*, the bark of *Prunus*, *Quercus*, and *Fagus*; petals of *Gentiana*, *Primula*, *Sorbus*, *Cyclamen*, *Hotteia*, and *Cornus*; stamens of *Eugenia*, *Drosera*, and *Melaleuca*; pistils of *Crocus*, *Salix*, *Euphorbia*, and *Rhododendron*; nectaria of *Passiflora*;

† A detailed description of this enzyme will be given in a special Bulletin of the U. S. Dep't of Agriculture. A preliminary note appeared in SCIENCE recently.

roots (epidermis) of *Saxifraga*, *Œnothera*, *Xanthoxylon*, and *Thesium*; fruits (epidermis) of *Punica* and *Camellia*. In the roots and fruits it seems to occur less frequently than in leaves and flowers, especially frequent is the occurrence in the epidermis and the fibro-vascular tissue.* Leaves in the shade contain less than those exposed to light, while leaves with partial albinism may contain in the white parts as much as in the green. In plants exposed to starvation by being kept in darkness it is gradually consumed with production of amido compounds.

It is generally stored up in the vacuole, but in some cases also in the cytoplasm. The method of proving its presence consists in the application of dilute solutions (0.5%) of weak organic bases as caffeine and antipyrine. These can easily enter the cells without killing the protoplasm immediately and can separate the active albumin in form of little globules which coalesce gradually to larger bright droplets whose changes by various reagents can easily be followed under the microscope.

Generally it will suffice to place small pieces of vegetable tissue in a few drops of caffeine solution and then tear them up into finer fragments by the aid of dissecting needles. In other cases it is preferable to let the caffeine solution act for a number of hours. These globular formations were designated by us as proteosomes. When the objects soon after the formation of the proteosomes are replaced in water the droplets will gradually disappear again in proportion as the caffeine or antipyrine leaves the cells again by osmosis. Return of the objects to the former solutions makes the droplets reappear. When, however, the cells die gradually or are killed by iodine solution or acids in high dilution, or by formaldehyde, hydroxylamine, diamidogen, prussic acid, free cyanogen, or salts of copper, or by vapors of ether, these droplets change their properties, becoming vacuolized, insoluble, and solid. Generally they become at first turbid from innumerable little vacuoles which in most cases unite soon and form one large vacuole, thus producing a hollow sphere representing itself under the microscope as a ring. If now the objects are placed again in water these changed proteosomes will not dissolve as they did before. The coagulation by heat is easily observed on dipping the objects in boiling water containing 5 per cent. of sodium chlorid. A change somewhat different is brought on by highly dilute ammonia of 1 per mille or less, inasmuch as the proteosomes thereby shrink and solidify but generally do not vacuolize as in the above cases.*

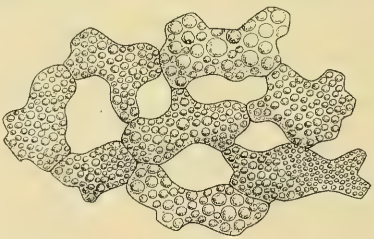

FIG. 1.

FIG. 2.

FIG. 1. Subepidermal cells of the lower side of the leaf of Echevera, after treatment with caffeine.

FIG. 2. Cells of Spirogyra treated with caffeine. The proteosomes produced show beginning vacuolization.

* Especially noticeable is the large amount present in insectivorous plants, *Utricularia* alone being devoid of it. In Cephalotus the large amount is especially remarkable. *Drosera* shows it not only in the leaf but also in stem and flower.

* A full description of the proteosomes is given in Chapters 9 and 10 of my treatise: 'Die chemische Energie der lebenden Zellen,' Munich, 1899. E. Wolff, publisher.

In dead cells caffeine never produces proteosomes. If we treat *Spirogyra*, which is an excellent object for studying the behavior of the proteosomes, for one minute with a dilute solution of iodine in potassium iodide the globules may still be produced immediately afterwards but not after ten minutes. It can easily be shown that the substance has not passed to the outside by osmosis, since the liquid surrounding the treated algæ does not show any reaction with caffeine. Various tests proved that the proteosomes consist of protein matter, but in most cases there are impurities present, especially tannin, a fact which has misled Pfeffer and some of his students so far as to assume these proteosomes to be merely compounds of tannin with common albumin and with caffeine. It is evident that such compounds would not exist in two different modifications and would not change their entire behavior with the death of the cells as above described. Pfeffer's objections are untenable, as repeatedly demonstrated. He has, for example, assumed that on the death of the cells certain compounds leave the protoplasm and upon entering into the vacuole cause there a change of the proteosomes. But it is easy to convince one's self that proteosomes can also often be produced in the cytoplasm itself, especially in the case of *Spirogyra*. Since these proteosomes remain in the cytoplasm also unchanged so long as the cells are alive, the assertion of Pfeffer is groundless. He has also argued that the phenomenon in question, viz, the production of proteosomes, may be due to the neutralization of the acid cell sap, but we have shown that the cell sap of *Spirogyra* has no acid reaction* and nevertheless it yields frequently numerous proteosomes.†

It is to be regretted that many plant physiologists rely upon the declarations made by some 'authority' instead of forming their own opinion from an unbiased critical investigation. The history of science shows that erroneous conceptions are often sustained for a long time in scientific circles simply because a man of a certain influence has defended them. The recognition of the genuine respiration of green plants furnishes a good illustration to this remark. Liebig, by weight of his authority, wiped out this truth for 20 years from science.

OSCAR LOEW.

U. S. DEPARTMENT OF AGRICULTURE.

* Botanische Zeitung, 1884.

† A careful observer will not confound these easily changing proteosomes produced only in living cells (as Dr. Albert F. Woods has suggested) with other globular masses produced by hypochlorite of soda upon the protoplasm of dead cells. Such formations and their distinction from proteosomes were described by Woods in SCIENCE, April, 1899.

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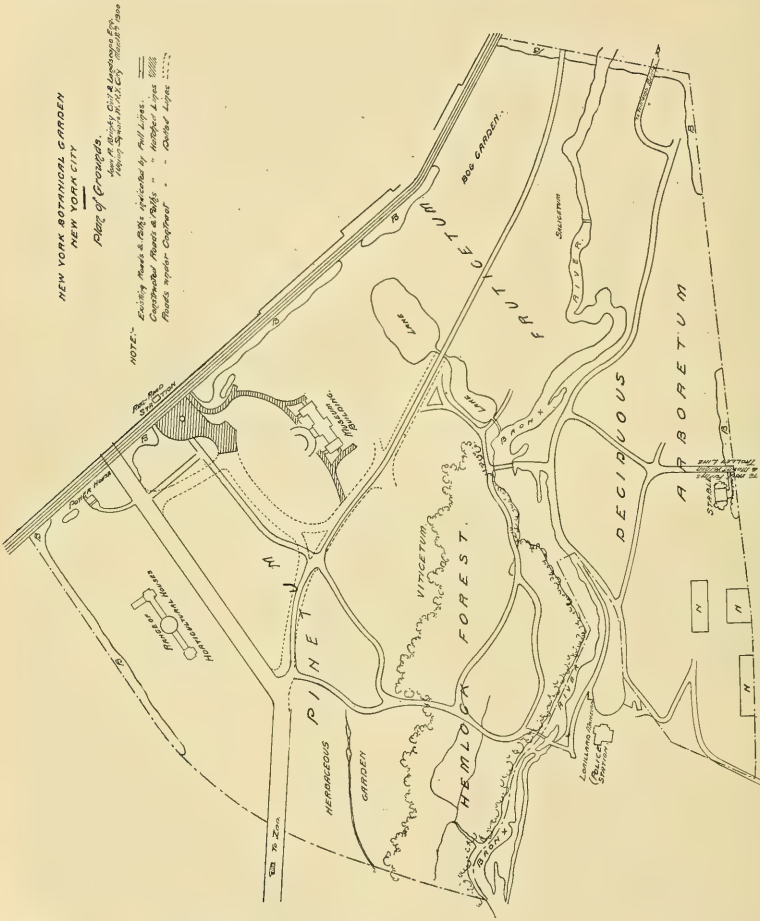
*THE NEW YORK BOTANICAL GARDEN.**

THE corporate body known as the New York Botanical Garden was created by an act of the legislature approved by the governor April 28, 1891, and amended March 7, 1894. This association was called into existence "for the purpose of establishing and maintaining a botanical garden and museum and arboretum therein, for the collection and culture of plants, flowers, shrubs and trees, the advancement of botanical science and knowledge, and the prosecution of original researches therein and in kindred subjects, for affording instruction in the same, for the prosecution and exhibition of ornamental and decorative horticulture and gardening, and for the entertainment, recreation and instruction of the people."

By the same act the Board of Commissioners of the Department of Public Parks were authorized to set aside two hundred and fifty acres of Bronx Park, and erect suitable museum and other buildings at a cost

* Written by the request of the Editor of SCIENCE. See also article on same subject by author in the *Popular Science Monthly* for June, 1900.

of not more than five hundred thousand dollars on condition that the corporation should raise the sum of two hundred and fifty thousand dollars within seven years. After the completion of the buildings these were to be handed over to the corporation which was to carry out the purposes for which it came into existence.



Map of New York Botanical Garden.

The subscription of the $250,000 required by the Act was completed, and the land was set aside in 1895.

The active work of organization of the

Garden was begun in 1896, and Dr. N. L. Britton was elected Director-in-chief in that year. The perfecting of the plans for the buildings, roads, driveways, walks and plantation occupied the greater part of the attention of the management during this year and the next. The actual erection of the most important of these structures, the museum building, was begun in the Spring of 1898, ground having been broken for it late in 1897, and it was handed over to the board of managers of the Garden in March, 1900. During this constructive period many additions were made to the staff, and a large amount of material suitable for the museums was accumulated, while much progress has been made in the building of driveways and the development of the plantations.

The area included within the Garden has been, and will be freely accessible to the public at all times, for the enjoyment of the beauties of the wild woodlands, and of the collections of living plants, but the completion of the museum and horticultural houses marks the beginning of the full activity of the institution and a brief description of the manner in which it discharges its chief functions may be of interest.

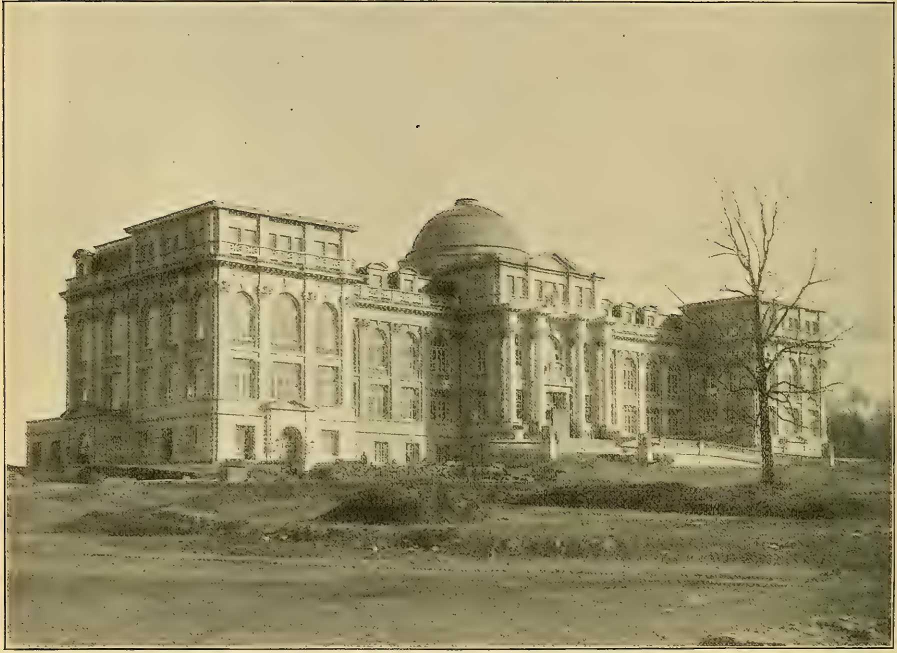
The collections of living and prepared plants in the plantations and museums are arranged to present information on the form, relationship, mode of life, habit, and general biological characters of the principal types of vegetation in such manner as to be capable of comprehension by persons unacquainted with the technical aspects of botany. A number of special groups of plants have been established in suitable places in the Garden. The trees are in the arboretum of the Bronx on the side and summit of a long ridge ; unassorted and reserve material of all kinds is kept in the nurseries on the eastern slopes of the same ridge ; the salicetum is established on the border of a marsh in the northern end of the Garden giving the willows and poplars the conditions under which they grow best. The fruticetum occupies an adjoining upland plain, affording space for the cultivation of a large number of shrubs, while the conifers are located on slopes to the westward of the hemlock forest. The viticetum is along the western edge of the forest, and the trellises of logs and timbers extending for a length of six hundred feet give suitable support to the vines. The herbaceous collection occupies an open glade to the westward of the forest and lies between two granite ridges. It is traversed through the middle by a small stream widened at places into lagoons for aquatic forms. About twenty-two hundred species are now in cultivation in this plantation. The wide border plantations which are established along the boundaries also offer opportunities for the growth of a great variety of trees, herbs and shrubs, and serve as screens and supplementary nurseries.

The horticultural houses, also erected by the city for the Garden and now essentially completed are located in the western part of the grounds at some distance from, and facing the museum. A palm house with a total height of dome of ninety feet is the central feature from which lower ranges extend on either side making a total length of front of five hundred and twelve feet.

The collections of living plants are arranged in the same system as the synoptic collection in the museum. Every plantation except the nurseries and boundary borders contains species of the same general habit, and the horticultural houses are used for the cultivation of forms which may not endure the outdoor climate of this locality. Not only will the plants from warmer zones be grown under glass, but when it is desired to develop native species out of their season they may be forced and brought to full development and bloom in the winter.

The museum is a fireproof building of brick, stone, and terra cotta, 308 by 110 feet, located in the western part of the grounds near the Bedford Park station of the Harlem division of the New York Central railroad. The building has a basement floor and three stories with a total floor area of nearly two acres, and window opening to half this amount, thus securing a good illumination, so highly desirable in a museum. A lecture theater occupies the basement floor of the western end, offering seating capacity for seven hundred hearers and furnished with all necessary appliances for the illustration of lectures. During the spring and autumn, courses of popular lectures are given on Saturday afternoons which have already drawn an attendance of from one hundred to five hundred. Adjoining the lecture hall are two large exhibition halls which are designed for horticultural shows and other temporary displays.

The first floor of the museum is devoted to the display of economic plants and their useful products. Glass fronted cases with movable and flying shelving are arranged in alcoves opening on the windows. Only about one-third of the case equipment of the building has as yet been set up. Dried specimens on herbarium sheets, conserved material in tubes, and jars, dry, and in formalin, and drawings, illustrate the method of preparation and appearance of the derivatives. It is of course utterly impossible



The Museum Building—New York Botanical Garden.

to demonstrate all the economic plants of the world or make even an approximately complete display within the space of a building, but the temporary installation now in place, represents many of the more important foods, drugs, timbers, woods, fibers, gums, waxes, resins, oils, sugars, starches, poisons, utensils, etc. The proper development of this collection requires a great amount of the most careful labor, and the curator has been fortunate in securing the co-operation of importers, producers, and manufacturers in the addition of exhibits.

The second floor contains a type exhibit of the vegetation of the globe arranged in families in the Engler and Prantl sequence. Specimens dry and in liquid preservatives, fruits, seeds, models, drawings and photographs are used to place the concept of the species before the observer. A set of hinged frames on standards contain the plants growing naturally within a hundred miles of New York City, and these are placed in their proper places in the series. Thus a case of the main series contains a representative of the family Violaceæ, and the frames near by display the local members of same family.

A number of microscopes of special design have been constructed for the purpose of displaying permanently the simpler and more minute organisms, or the structure of the higher forms.

The preparation of the material used in the exhibits is carried on in a number of rooms in the basement floor, and the members of the staff engaged in this work are assisted by a cabinet maker and printer.

The entire area of the Garden has been handled most sympathetically by those in charge of the architectural features of the Garden. The buildings were erected in the more open western part of the grounds, which offered the least valuable landscape features, and the surface around them has been improved by plantings. The natural beauties of the tract have been most zealously guarded from disturbances of all kinds. The attractive panorama of wild woodland and stream offered to the artist and lover of nature have been left absolutely untouched, but made more valuable by increased ease and safety of access. Thus to the general public, the Botanical Garden offers all the privileges enjoyed by them in the original park together with the interesting displays offered by the large special collections of interesting plants in the plantations and horticultural houses, as well as the exhibits in the museum. The increasingly large number of visitors attests the popularity of this feature of the institution.

Another class of constituents consists of the patrons, fellows, life members and annual members of the Garden, who now number over nine hundred. A person becomes an annual member on invitation of the Board of Managers and payment of ten dollars per year, and enjoys certain privileges among which are: tickets to all lectures given under the auspices of the Board of Managers either at the Garden or elsewhere, invitations to all exhibitions given under the auspices of the Board of Managers, a copy of all handbooks published by the Garden, a copy of all annual reports, copies of the monthly *Journal*, and an opportunity to buy some of the other publications of the institution at reduced prices.

One of the most important functions of the Garden consists in the advancement of the technical knowledge of botany and the furtherance of research in all subdivisions of the subject.

The collections in the plantations, horticultural houses and museum offers an excellent melange of material upon which investigations may be based, and the herbarium, library and laboratories are the direct means for the facilitation of such research work. The Garden, as an independent institution, offers its facilities to advanced students or investigators from any part of the world who may secure registration in the proper manner. Persons thus registering at the Garden are entitled to the privileges of a student at Columbia University without payment of further fees in accordance with the terms of a contract in existence between the two institutions. The essential features of this agreement stripped of formal verbiage are as follows: the herbarium and botanical library of the University are deposited at the Garden, the graduate work of the University in botany is carried on at the Garden under the guidance of a member of the staff of the Garden or of the University according to the election of the student: students registered at the Garden may elect work with members of either staff, and are entitled to the privileges of a student in other lines in Columbia University.

It is to be noted that the Garden is not enabled to confer degrees, but the advanced student may become a candidate at Columbia or other institutions of university rank.

Twenty-two students have had the privileges of the Garden during the collegiate year now closing. Eight of these were registered as students at the Garden and fourteen from Columbia. Two of these have undergone the examination for the degree of doctor of philosophy, and three for master of arts in Columbia University.

Main Horticultural houses: view from the northwest. New York Botanical Garden.

The great diversity of natural conditions offered by the area comprised in the Garden, includes the widest range of cultural conditions, and in connection with the horticultural houses gives ample facility for work with living material. These advantages have already been realized in the cultural tests of critical or little known species, and in physiological experimentation.

The range of investigations which may be carried on in any institution is limited by its collections of living and preserved specimens and the accomplishment of researches upon this material depends directly upon the facilities offered by its herbaria, library, and laboratories, and the spirit in which these opportunities are administered.

The main herbarium, library, and laboratories of the New York Botanical Garden are chiefly located on the third floor of the Museum and their arrangement is illustrated by the diagram in figure 4.

The main herbarium occupies a room eighty-five by forty-seven feet in the east wing, which is illuminated by four large skylights in addition to the windows. The plants are arranged in two parallel series of cases occupying opposite sides of the room, with large oak tables in the middle and at the ends of the room.

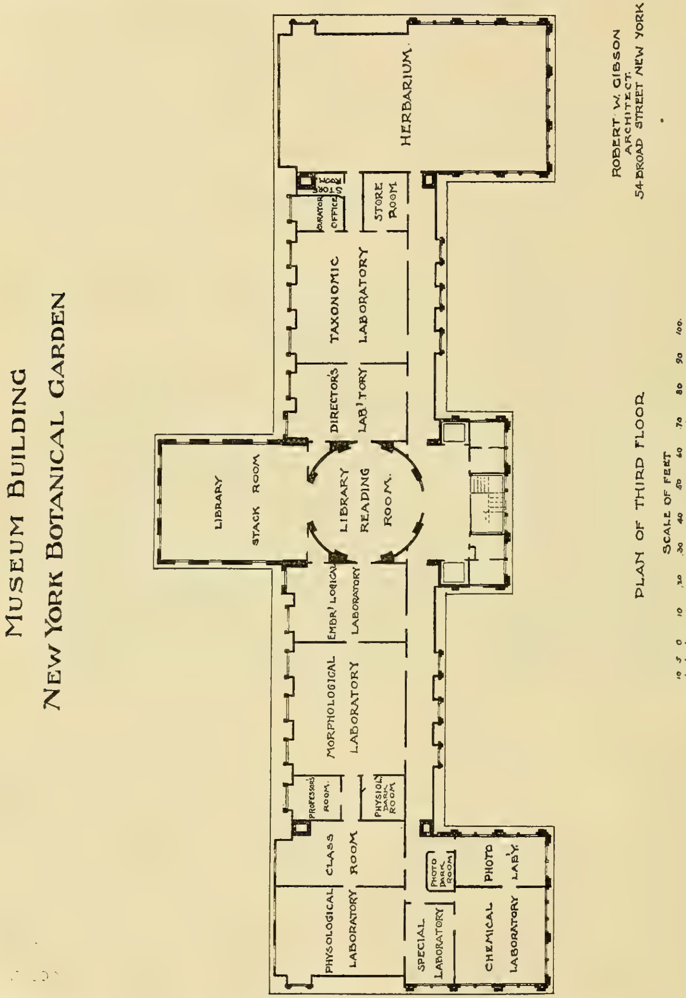
The Columbia University herbarium occupies the western side of the room, and "it is one of the oldest, and in itself one of the largest in America, contains over 600,000 specimens. This herbarium was begun early in the century by Dr. John Torrey, and contains the material upon which his classic botanical writings, extending over half a century, were based. Upon his death, 1873, this collection came into the possession of Columbia College. On this as a foundation the present Columbia herbarium was built. Mr. John J. Crooke presented two valuable collections to Columbia; the one, that of Professor C. F. Meisner, of Basle, Switzerland, one of the world's leading botanists, the other that of the late Dr. A. W. Chapman, of Apalachicola, Florida, in which are contained the specimens upon which Dr. Chapman founded his 'Flora of the Southern United States.' A few years later the mosses, and many of the hepatics and lichens accumulated by Mr. C. F. Austin, came into the possession of Columbia, while the latest acquisition of great size and importance, secured through the kindness of friends of the university, was the famous collection of mosses brought together from all parts of the world by the late Dr. J. G. Jaeger, of Switzerland. To this ample nucleus Dr. Torrey's successor, Dr. N. L. Britton, while professor at Columbia, and his associates, added continually by securing collections from all parts of the globe, and by special collecting trips to various parts of North America.

The most complete sets of specimens secured on two noteworthy South American journeys of exploration are here preserved; the one trip was that made by Dr. Rusby through the Andes of Bolivia, the other that of Mr. Morong in Paraguay and Chili."

The Garden has accumulated about 200,000 herbarium specimens since its organization. In this number is included the famous Ellis collection of fungi, including over a hundred thousand and forming one of the largest and most complete collections of fungi in the world, outranking any similar collection in America. Various private herbaria have been acquired by gift and purchase, among which are those of John J. Cooke, F. M. Hexamer, H. E. Hasse, P. A. Rydberg, Lewis R. Gibbes, Peter V. LeRoy, Harry Edwards, Anna M. Vail and Francis E. Lloyd. Accessions are being made at the rate of fifty to a hundred thousand specimens per year.

The main herbarium room is supplemented by two store rooms, and the office of the curator of the museums near it. In addition adequate preparation and storage rooms in the basement serve for the reception and handling of duplicate and unmounted material, as well as for the press upon which final labels are printed. Directly west of the herbarium suite is the taxonomic laboratory, which is especially adapted for systematic and anatomical investigations.

The laboratory of the Director-in-chief occupies a large room between the taxonomic laboratory and the library. The embryological laboratory occupies a corresponding position on the other side of the reading room, and opens into the main morward, and also receive indirect light from the hallway through numerous glass panels.



Plan of laboratories, libraries and herbarium, New York Botanical Garden.

phological laboratory. These laboratories are illuminated by windows facing northThe instrumental equipment of the laboratories comprises a number of microscope stands suitable for investigators, from the most prominent makers, and a full complement of objectives, immersion and apochromatic. The outfit in question has been planned to meet the habits and prejudices of workers from any part of the country, and it has been found possible to duplicate the apparatus to which any student has become accustomed.

The construction for special furniture for the laboratories awaits the definition of the forms most suitable for the character of the work which may be undertaken here.

A most interesting comparison with the battery of modern high power optical apparatus on hand, is afforded by a collection of old microscopes given by Mr. Chas. F. Cox of the Board of Managers, which forms a special laboratory exhibit. This collection illustrates the development of the microscope during the last century and a half.

The physiological dark room opens from the morphological laboratory, and is fourteen feet square with double doors and independent ventilation, connecting directly with the outside air. It is heated indirectly by the walls of the contiguous rooms, and its position in the middle of the wing of the building together with its content of over thirty-five hundred cubic feet of air secure for it a very equable temperature. This room has been in constant use for six months including the period of tests of the heating system of the building and the total range of temperature has not exceeded four degrees centigrade, and at no time has a variation of two degrees been noted in a single week. The humidity varies from sixty to eighty per cent. in the work now in progress, and it has been found to offer much more suitable conditions for experimental work than any room used for a similar purpose which has come under the notice of the writer.

A corridor leads from the morphological laboratory to the class-room between the dark room and the office of the director of the laboratories (Professor's room, Fig. 4). The class-room is thirty-five by twenty feet, and one end is furnished with such accessories as to make it suitable for the weekly convention of workers from the laboratories. The other end serves for the private laboratory of the director of the laboratories and contains the departmental library.

The physiological laboratory is a sky-lighted room, thirty-five by thirty-two feet, occupying the corner of the building. It has a stone floor set in water-tight cement, a tank for aquatics, and tables for cultures. An ample heating surface is provided, and a special system of steam pipes around under the skylights secures ventilation, and acts as a preventive of dripping moisture. Ventilation of the ordinary type and that of the greenhouse are provided, while a set of shades may be used to cut off the direct rays of the sun. By such means a range of temperature similar to that of an intermediate greenhouse is secured. To this room are brought specimens from the plantations and greenhouses for experimental and observational purposes, and these are removed as soon as the work with them is finished.

A small chemical laboratory opens from the physiological laboratory, and leads into the large chemical laboratory occupying the corner of the wing. This room has not yet been provided with the special furniture and fittings necessary for chemical work. It has a large ventilating hood leading into a duct into which all the ventilating flues of the room empty. A ventilating fan driven by a powerful motor is capable of renewing the entire body of air in the room in a few minutes and thus preventing the escape of noxious gases into the contiguous laboratories.

The second corner of the wing is occupied by the photographic laboratory and balance room, which is equipped with an outfit comprising a set of screens, cameras, and a selection of anastigmatic and planar lenses which provide for almost every contingency of indoor and outdoor work, including photomicrography and projection. The adjoining dark room opens directly into the hallway and contains the apparatus necessary for developing the printing.

The basement floor of the museum contains two rooms devoted to laboratory purposes. One is planned for the storage of chemicals and other supplies, for glassblowing and general preparation work. The second is a constant temperature room, thirty-four by twenty feet, furnished with double walls, doors and windows; this is designed to be separated into several smaller chambers in which different temperatures may be maintained. A series of thermographic tests of the temperature resulting from outside and inside causes are now in progress, from which the final fittings necessary for absolute control of the different temperatures may be determined.

The worker who comes to the herbarium or laboratories is supposed to have already demonstrated his ability to carry on independent research work, and after he has been provided with the necessities for the prosecution of the work he has only so much of advice and consultation with the member of the staff under whom he has elected work as to insure its successful prosecution. No facilities are given for elementary instruction. All the members of the staff and the workers in the laboratories meet once every week to listen to the presentation of results accomplished by one of their number, or by some visiting botanist. The opportunity for the discussion of newly found results has been found most stimulating to the persons concerned, and interesting to all attending.

The library consists of a large reading room or rotunda under the dome, of a stack or book room to the rear in the square central wing and two small store rooms for pamphlets and duplicates.

The stack room is admirably lighted by three west, four north and three east windows, and by a long central skylight. The reading room is lighted both from the windows in the dome and from the stack room, and is furnished with chairs and large oak tables.

The book stacks are forty in number, arranged along both sides of the book room. They are constructed by steel plate of one-tenth inch in thickness, are double-fronted, made in sections four feet long, two feet deep and six and a-half feet high, with solid ends and tops, but no fronts or doors, the lowest shelf being about three inches from the floor. They are painted a dark olive-green in japanned finish. Each stack is provided with five movable shelves with adjustable space or holes on the inside of the cases about one inch apart, through which small bolts are thrust to catch the shelves. For the folios there are four large metallic double-fronted cases, three feet high with a table top five by three and a half feet, in the center of the stack room. Each case has two sections on each front, one with three plain shelves and the other arranged with a system of roller shelves for the easier handling of the heavier folios.

In accordance with the agreement with Columbia University all the botanical books of this institution, amounting to about 5000, are deposited here. The Garden has acquired about 2000 volumes since its organization. The general character of the library may be known when it is stated that an invoice, February 1, 1900, showed 127 volumes of general dictionaries and non-botanical reference works, 100 volumes on general science, 200 volumes on geology and paleontology, 1733 volumes of periodicals and proceedings, 52 volumes of collective and historical works, 495 volumes on morphology and physiology, 50 volumes on geographic distribution, 2105 volumes of floras and taxonomic monographs on the phanerogams, 900 volumes on cryptogams, 640 volumes on agriculture, 325 volumes on gardening, 200 volumes on forestry and 200 volumes on meteorology. The total number of volumes on the shelves was 7117. Since this count was made the additions raise the total to about 8000. Some care has been taken to exclude books and proceedings which have only an incidental interest to botany, with the idea that such additions decrease the actual working efficiency of the library and increase the labor necessary for its administration. The books are classified according to the Dewey system of indexing, and pamphlets and separates are not indexed or included in the count until bound up in volumes by subject.

The collective efficiency of the facilities described above is such that the institution bids fair to meet the expectations of all its different classes of constituents. The large number of specialists of the staff, together with those of other institutions who offer to guide research here, gives the student, who may come here to carry on investigations, the widest range of election of work. Among those offering to guide research in the Garden are: Professor L. M. Underwood, Dr. C. C. Curtis, Dr. M. A. Howe, Dr. N. L. Britton, Dr. D. T. MacDougal, Dr. P. A. Rydberg, Dr. G. V. Nash, Dr. J. K. Small, Professor F. E. Lloyd, Mrs. E. G. Britton, and Professor E. S. Burgess.

The personal interest and care shown by the members of the Board of Managers in the organization of the Garden has resulted in placing it on its present broad foundation, while the energetic administration of the business details by the Director-in-chief has brought the institution through the most critical part of its constructive period without departure from the original plans, without financial deficit, and with no undue loss of time.

The original guarantee fund has been preserved intact and increased by gifts and bequests to nearly $300,000, the income of which is available; a second source of income consists of the fees of the members, and a third source is the support received from the Department of Public Parks of the City of New York.

D. T. MACDOUGAL.

SCIENTIFIC BOOKS.

The Unknown. By CAMILLE FLAMMARION. Harper & Brothers. 1900. Pp. 488.

This volume consists of a plea for the existence of unknown or unrecognized psychical forces or manifestations, and an attempt to popularize this branch of investigation, by an astronomer who is known for similar contributions to other fields—some of them of a pronounced imaginative type. When one applies to the work the critical examination which science demands, the estimate of its value must be distinctly unfavorable. Its defects are many and serious; its merits do not go beyond those included in a laborious compilation of refractory material and a thorough and sincere interest. Its contents include two introductory chapters on the dangers of excessive incredulity as well as of a too ready credulity; a large collection of cases of communications made by the dying and regarded as evidence of telepathy; a similar collection of related cases of thought transmission and clairvoyance under other conditions; a consideration of dreams and of premonitions and of hallucinations, mainly again as indicative of abnormal psychic operations; and some scattered and weak attempts to interpret these phenomena on a telepathic and 'psychic force' hypothesis. The dominant tone of the book is one not uncommon in French writings of similar purpose, and one particularly unattractive to the Anglo-Saxon intellect; there is much protesting of the necessity of careful observation and of not accepting anything except on a sufficient evidence, and again of the limitations of human knowledge and of the readiness with which even learned men make mistakes and form prejudices, and of the ultimate possibility of almost any theory and belief; there is much use of analogies without any discernment of the essential likeness or unlikeness upon which the value of all analogies rests; there is an attempt to write the matter up for and down to the public which when put into matter-of-fact and not too skillful English produces an unfortunate impression of self-assurance and an assumption on the part of the writer of an intense interest in his opinions on the part of the public.

Viewed as a contribution to a domain of knowledge most familiarly known as 'Psychical Research,' the work's fundamental faults are a lack of critical judgment in the estimation of evidence, and of an appreciation of the nature of the logical conditions which the study of these problems presents. In this respect it forms a marked contrast with the best of the English contributions to the same topics, notwithstanding an essential agreement of results. Although the motto of one of the chapters is 'Des faits! Pas de phrases,' the readiness of the author to accept as real fact the elaborated and often biased report of an unskilled witness, and to pay himself with words in his own use of the evidence, are lamentably conspicuous. A writer who can say of the reports of 4280 miscellaneous correspondents who reply to his request for cases of unusual 'psychic experiences'; "What struck me in all these narratives was the loyalty, good faith, frankness, and delicacy of the writers, who were careful to tell only what they knew and how they came to know it, without adding to or subtracting anything from the subject. Every one of them was the servant of truth," gives more evidence of his confidence in human nature than of his fitness to undertake such an investigation. A writer who can cite the persistence of sensations referred to amputated limbs, and the familiar principle of 'eccentric projection' that the sources of our sensations are referred outward to an external object, and the subjective character of color sensations, as psychological data suggestive of or corroborative of telepathy; who can transfer the physical principle of sympathetic vibration to imaginary brain vibrations and state that "All facts relating to the production and association of ideas can be explained by the occurrence of vibrations of the brain and of the nervous system which originates in the brain; this was demonstrated by David Hartley in the last century," gives further evidence of his incapacity for the task which he has elected to perform.

From beginning to the end of the volume there is no evidence that the author has considered or is familiar with the explanations of a non-telepathic nature which have been offered for some of the facts with which he deals. The fact that hypnotized subjects are quick to seize and act upon the unconscious wishes or suggestions of their hypnotizers is put down as evidence of telepathy without mention of other far more simple and more adequately demonstrated explanations; and the considerable evidence for regarding many 'veridical' presentiments and premonitions as illusions of memory is likewise ignored. Instead of a carefully developed logical argument, strengthened at every step by an examination of rival hypotheses and of the sources of error inherent in the evidence; instead of the critical analysis and differentiation of cases and a discernment of the prominent factors of community and divergence of the observations; we have only reiteration with increasing emphasis of the truth of the author's favorite hypothesis, and an endless compilation of stories that may be interesting and even significant but hardly justify the purpose to which they are applied. "Brains are centres of radiation." "But the actual FACT of the action of the soul at a distance is now demonstrated." "*The action of one human being upon another, from a distance, is a scientific fact; it is as certain as the existence of Paris, of Napoleon, of Oxygen, or of Sirius.*" "There are *mental transmissions, communications of thoughts, and psychic currents* between human souls." "PSYCHIC FORCE EXISTS. ITS NATURE IS YET UNKNOWN." "We may *see without eyes and hear without ears*, . . . by some interior sense, psychic and mental." "The soul by its interior vision, may see *not only what is passing at a great distance*, but it may also know in advance *what is to happen in the future*. The future exists potentially, determined by causes which bring to pass successive events." If such statements as these are warranted by the evidence which is offered, then the logic of this science is not that of the other sciences.

The popular interest in the topic which this volume treats, the obvious intention to gain the ear of the public by recounting tales of merely personal interest and passing them off as scientific data, the confident expression of the author in the certainty of his conclusions, will all combine to circulate the notion among the public at large that the conclusions of the volume represent the final verdict of science on these momentous questions; and it is in this respect that the volume is likely to exert a seriously unfortunate influence. It is difficult enough at best to get the intelligent layman to understand that the ability to interpret soundly and rationally phenomena of this field demands, like all expert opinion, a special knowledge and a fitness of training and intellect. It is quite idle to expect the layman to distinguish too closely between one scientist and another, or between the methods which they use and the dicta which they express. Possibly (and it were better if one could say probably) M. Flammarion has so seriously overstepped the limits of sound judgment and expression in this matter, that his authority will be called into question by the reader who reflects as he reads. There is no good reason why an astronomer with a gift for popularization and an interest in the phenomena of the 'Unknown' should not prepare as good and valuable an account of these phenomena as the present state of knowledge permits. There is no desire on the part of psychologists to discountenance such investigation, whatever its origin. But it is essential that the investigator should thoroughly know what the present state of knowledge really is, and above all, that he should possess the indispensable logical appreciation of the conditions of the various problems.

This logical vigor and discernment, this essential logical insight that is both a natural endowment and the result of conscientious training is not the prerogative of any one science nor of scientists at large; and he who has it has the most important part of the equipment necessary to the participation in such investigations. It is because this volume is conspicuously lacking in these qualities, and because it as a consequence substitutes for them uncritical collections of narratives and dogmatically stated conclusions, that it must be disavowed by those who stand for the thoroughly scientific investigation of the unexplored regions of the psychological universe. It is very certain that if M. Flammarion and his colleagues had used the same methods in astronomy as he applies to the investigations of this volume, modern astronomy would be held in very different repute from that which it now enjoys. There is an amateur and an expert exploration of this field, just as there is in geographical exploration, and it will require the best trained and most scientific explorer to reveal the true nature of this 'darkest Africa' of the human mind.

JOSEPH JASTROW.

Histoire des mathématiques. Par JACQUES BOYER. GEORGES CARRÉ et C. NAUD, Éditeurs. Paris. 1900. Pp. 260.

The growing interest in the history of science is made manifest by the number of historical works which have appeared in recent years. Perhaps in no science is this movement so marked as in mathematics. During the last twenty years there have appeared not only the monumental works of Moritz Cantor and Maximilien Marie, but also a large number of brief histories. The volume before us belongs to the latter class.

An attractive feature of this book are the page-portraits of nineteen mathematicians and seven facsimiles of parts of celebrated manuscripts and of old drawings of mathematical instruments. We know of no other general history of mathematics which furnishes the reader such a treat. So high is our appreciation of this feature that we are ready to forgive the author when we discover that, out of a total number of nineteen mathematicians whom he has honored with portraits, eleven are Frenchmen.

M. Boyer's history is written in an interesting style and will doubtless stimulate more serious study of mathematical history in larger works. But in two respects the author has hardly achieved what might have been expected of him.

In the first place, the author has in several instances failed to embody the latest fruits of historical research. Thus, in connection with the graphical representation of imaginaries he fails to mention Wessel; in speaking of non-Euclidean geometry he refers to Saccheri, but not to Lambert and Taurinus; in tracing the history of trigonometry he apparently overlooked the researches of Suter and Braunmühl, who show that the Arabs distinguished themselves by original work much more than was formerly supposed; he makes no mention of the Bakhshali manuscript, which throws considerable light on early Hindu arithmetic. As a rule, the facts presented are stated accurately. Among the exceptions are the following: Athelard of Bath is mentioned as the first translator of Euclid from the Arabic into Latin, but there is ground for the belief that earlier translations existed. Boyer attributes to Benjamin Peirce a research which seems to be due entirely to Charles S. Peirce; he misspells the name of Crozet, the author of the first American text on descriptive geometry; he gives Antissa instead of Antinoeia as the birthplace of Serenus.

In the next place, the book is deficient because it does not trace the evolution of theories. Something on the growth of mathematical ideas we have a right to expect even in a short history. If the reader consults this work on the introduction of the notion of infinity or of continuity, on the evolution of the theory of limits, on the number concept, or on the foundations of algebra, he will receive little satisfaction. But these topics are all of vital importance in elementary as well as in advanced mathematics.

FLORIAN CAJORI.

COLORADO COLLEGE, COLORADO SPRINGS.

Elementary Chemistry. For High Schools and Academies. By A. L. AREY, C.E., Rochester (N. Y.) High School. New York, The Macmillan Co. 1899.

The author has adopted the theoretically ideal plan of forcing the student to note the various features of chemical reactions without any suggestion as to the phenomena which one is expected to observe. Very few students have cultivated and trained their power of observation, and one of the most advantageous purposes of the study of a science is to develop this side of their nature. This can only be done by teaching him what he sees and how he should see it and thus gradually training his powers of observation until he is able to observe new phenomena for himself and becomes independent of the observations of others. Several dangerous experiments are placed in the early part of the book with no notice of the precautions to be taken, and if this book was put into the hands of an inexperienced worker there would probably be disastrous results.

J. E. G.

Laboratory Exercises with Outlines for the Study of Chemistry, to accompany any Elementary Text. By H. H. NICHOLSON, Professor of Chemistry in the University of Nebraska, and S. AVERY, Professor of Chemistry in the University of Idaho. New York, Henry Holt & Co. 1899.

This book is intended as a laboratory guide to be used in connection with a text-book. It is well arranged and the descriptions are clear and logical, and with conscientious use of a reference book should produce the desired results. In cases where dangerous materials are to be handled too much caution cannot be given. In exercise 3 the student is directed to rub in a mortar a piece of sulphur and a crystal of potassium chlorate the size of a grain of wheat. One who had never had experience with students just beginning the study of chemistry would be surprised at the differences of opinion as to the size of a grain of wheat.

J. E. G.

School Chemistry. By CHAS. BASKERVILLE, Ph.D. The University of North Carolina. Richmond, Va., B. F. Johnson Publishing Co. 1899.

The author wrote this book for use in summer schools for teachers. In attempting to cover the whole field in a short course he has prepared a work which will not give a student the necessary foundation either for teaching the elements of the subject or continuing its study with advantage. A few subjects thoroughly understood would probably be of more value than a little knowledge of many, so far as its use by the class of students for whom it is intended is concerned. The author has no doubt supplemented it by valuable class and laboratory instruction as he reports its use for five years with success.

J. E. G.

The Living Organism. An Introduction to the Problems of Biology. By ALFRED EARL. London, Macmillan & Co. 1898. Pp. xiii + 271.

This book gives the too wordy reflections upon biological phenomena of an author who seems to have a fair general acquaintance with biological principles, but no very extensive knowledge of biological facts. The consequence is a book which is philosophical in form, discusses biological phenomena in an extremely general and abstract way, contains few errors, but, on the other hand, has little of suggestiveness for the advanced biologist. The style is flowing, but often obscure; and after reading a few pages one wearies of the pedantry which clothes well-known and simple ideas in a heavy blanket of abstract verbiage. Thus, the fact that organisms assimilate is put (in Italics) thus: "Both animals and plants depend for their continued existence upon certain material which is absorbed and changed in properties by contact with the living body." This is typical (p. 227): "The remarkable constancy of the living form, one of its distinctive signs, even when united in thought with the ceaseless occurrences tending to disturb that form, gives no positive indication of other than physical agents. Indeed, it is only by a just apprehension of everything that concerns or affects the organism, in other words, by a due regard to external changes as well to the more prominent activity of the organism, that it is possible to gain coherent knowledge of the fact known as life." We must conclude that the book contains little of importance for the working biologist.

C. B. DAVENPORT.

SUTER'S HAND-BOOK OF OPTICS FOR STUDENTS OF OPHTHALMOLOGY.

This little book, as its title implies, contains such small portions of geometrical optics as may be useful directly to a certain limited class of students. Like all fragmentary text-books, it suffers under the difficulties of such special treatment. Many important portions of the subject are omitted or barely mentioned, and only those are developed in detail which appertain directly to the object in view. Thus the introductory and general portions, including the general treatment of refraction, are condensed almost to obscurity, and, considered as demonstration, are incomplete. Refraction through spherical surfaces is much more satisfactorily handled, and is succeeded by an excellent chapter on lenses, following in general the methods of Gauss. In both these chapters the use of algebraic signs is somewhat arbitrary and inconsistent. The principles thus expounded are then applied to the eye as an optical instrument, both in its normal condition, and in connection with the spectacle lenses used to correct its errors of refraction. These chapters form, as was to be expected, the most important part of the book. They are clear and instructive, and well illustrated by numerical examples. They are followed by discussion of cylindrical lenses, and prismatic glasses. The final chapters on the ophthalmoscope are too brief to be of great practical benefit.

The whole presentation of the subject is adequate to its immediate purpose, though the rare student of ophthalmology who has enough interest in the optical side of his work really to profit by this book would find it much more to his advantage to read instead a larger and more complete treatise.

FRANK P. WHITMAN.

BOOKS RECEIVED.

Memoirs Presented to the Cambridge Philosophical Society on the Occasion of the Jubilee of Sir GEORGE GABRIEL STOKES, Bart, Hon, LL.D., Hons. ScD. Lucasian Professor. Cambridge, at the University Press; New York, The Macmillan Company. 1900. Pp. xxviii + 447 and twenty-five plates. $6.50.

Papers on Mechanical and Physical Subjects. OSBORN REYNOLDS, F.R.S. Cambridge, The University Press; New York, The Macmillan Company. 1900. Vol. I, pp. xv + 416. $5.00.

An Introduction to the Study of the Comparative Anatomy of Animals. GILBERT C. BOURNE. London, George Bell & Sons; New York, The Macmillan Company. 1900. Vol. I, pp. xvi + 269. $1.10.

Zoological Results, based on material from New Britain, New Guinea, Loyalty and elsewhere, collected during the years 1895, 1896 and 1897. ARTHUR WILLEY. Cambridge University Press;

New York, The Macmillan Company. 1900. Part IV, pp. viii + 354–530, plates xxxiv–liii. 21s.

Biological Lectures from the Marine Biological Laboratory at Woods Holl, 1899. Boston, Ginn & Company. 1900. Pp. 282.

SCIENTIFIC JOURNALS AND ARTICLES.

The American Naturalist for May, opens with a detailed account of 'Marine Biology at Beaufort,' by H. V. Wilson, calling attention to the advantages of this locality as a field of research. J. G. Needham describes 'The Fruiting of the Blue Flag (*Iris versicolor* L.)' noting the effect of civilization in altering its environment. Chas. W. Hargitt presents 'A Contribution to the Natural History and Development of *Pennaria tiarella* McCr.' and R. W. Shufeldt reviews 'The Ornithological Results of the Polar Expedition under Dr. Nansen.' The ninth part of 'Synopses of North-American Invertebrates' is by Nathan Banks, and is devoted to 'The Scorpions, Solpugids and Pedipalpi.' There are numerous reviews of recent literature.

Bird Lore for June has for its leading article, a comparison of 'Song Birds in Europe and America' by Robert Ridgway, which is very favorable to our native birds. William L. Baily describes 'The Kingfisher's Home-Life,' with illustrations of the young at different ages, and Laura G. Page has an article on 'Swallows and Feathers.' Florence Merriam Bailey tells 'How to Conduct Field Classes,' and there is a notice of the course of 'Bird Study at Wood's Holl Marine Biological Laboratory.' There are some interesting notes, and in the Audubon Department an important agreement of the members of the Millinery Merchants Protective Association regarding the importation, manufacture and sale of North American birds, by which the Association agrees not to use any more North American birds after the stock on hand is exhausted, in return for which the Audubon Society and Ornithologists Union are to do everything in their power to prevent the passage of laws interfering with the manufacture and sale of ornaments made from the plumage of barnyard fowl, edible birds, game in season and foreign birds.

SOCIETIES AND ACADEMIES.

THE ACADEMY OF SCIENCE OF ST. LOUIS.

At the meeting of the Academy of Science of St. Louis on the evening of May 23, 1900, the following subjects were presented:

A paper by Dr. Adolf Alt, entitled 'Original contributions concerning the glandular structures appertaining to the human eye and its appendages,' was presented by title.

Dr. M. A. Goldstein read a paper on 'The physiology of voice production,' in which he discussed three essential factors in the production of voice: the motor force, the organ of sound, and the resonators. The essential features presented may be summarized as follows: (1) All elements carefully considered, the best form of breathing applicable to voice production and singing is the rational combination of the costal with the diaphragmatic type. Reserve force in breathing is best attained by deep inspiration, fixation of the distended diaphragm and thorax, and control of these muscles while tone is produced. (2) To facilitate vocalization, the larynx should never be tightly contracted by the muscles of the throat, especially in the production of the registers. (3) On the resonating cavities, their proper conformation and position in relation to the vibrating cords and larynx, depend the quality and timbre of the voice, so that the careful and proper placing of tones is perhaps the most essential factor in voice production.

Professor F. E. Nipher read a short communication on the zero photographic plate, to which reference was made at the meeting of May 7th, and in his paper published as Vol. X., No. 6, of the Academy's Transactions.

The zero plate is one upon which a photographic image has been made, but which will develop no image in a bath placed in light of given candle power, at a distance of one meter from the source. For example, if the developing bath is twenty centimeters from a sixteen candle lamp, a Cramer isochromatic plate, such as is called 'instantaneous,' held for ninety seconds at a distance of one meter from the lamp, will be a zero plate. With an opaque stencil over the plate when placed in a printing frame, during the exposure, there will develop a positive of holes through the stencil, if the exposure is longer, and a negative if the exposure is shorter. The bath used in the above illustration must be weak and cool.

If a fresh plate is exposed in our camera with full opening to a brilliantly lighted street scene for one minute, it will develop as a positive in that same bath. This time can be somewhat reduced, but the least time needed has not yet been determined. It is evident that part of this minute is used in producing a zero plate. It is furthermore clear that different parts of the plate will arrive at the zero condition at different times. The exposure may be arrested at a time when the strongly lighted white background of a sign-board will develop white as a positive, and when the black letters will also show white as a negative.

It has been found that when a plate is uniformly exposed over its whole surface to the extent that nothing would have developed had it been covered by a stencil, this plate may then be placed in a camera and exposed in the ordinary way, and a perfect positive will develop in the bath to which it has been adapted. This preliminary spoiling of the plate for developing a negative is a very advantageous preparation for taking a positive. It shortens the time of exposure, and ensures that a positive shall be obtained over all parts of the plate. It is not yet known how short the camera exposures may be made, but the present indications are that they will be as short as those now made in the taking of negative pictures.

It is currently believed by photographers that in a positive plate the object has 'printed its picture' upon the plate. This is an entire misconception of the process. It is true that in an exposure of long duration an image shows on the plate before it is placed in the bath. But this image is blackest where the light has acted most. It is a negative. This picture disappears in the developing bath when illuminated. The plate becomes perfectly clear. The positive picture then develops, exactly as a negative would under ordinary conditions.

Mr. J. B. S. Norton presented some notes on the flora of the southwestern United States. Maps were shown indicating the parts of this region and others not well represented in herbaria, as compared with other sections of the country. Among other interesting features of the Southwest was mentioned the production of many different forms or closely related species in the isolated mountains surrounded by deserts. This was compared with insular conditions and illustrated by the mountain forms of Euphorbia. Specimens of some new species from southwest Missouri were also shown.

Two persons were elected active members of the Academy.

WILLIAM TRELEASE,
Recording Secretary.

NEW YORK ACADEMY OF SCIENCES.
SECTION OF BIOLOGY.

AT the regular meeting of May 14, 1900, Professor F. S. Lee, presiding, the following papers were presented:

'Some Chemical Notes on the Composition of the Cocoanut,' by J. E. Kirkwood and Wm. J. Gies.

The authors have carried on qualitative work on the ungerminated nut, preparatory to a study of the digestive processes during germination. The chief constituents are cellulose and fat. Some soluble carbohydrate is present, beside globulin and proteose, but no albumen or pepton. Only amylolytic ferments have so far been found. The milk of the nut is normally acid, probably due to acid phosphate. It contains an earthy phosphate, reduces Fehling's solution, sours on standing, and acquires much the odor and physical appearance of soured cow's milk. It shows only small quantities of proteid and fat.

The meat of the average nut contains from two to three grains of globulin, which may be obtained in crystalline form. The authors have made three preparations by the usual methods. The nitrogen averages for these were 17.91%, 17.81%, 17.68%. The ash for the same, 0.13%, 0.41%, 1.05%. From the meat of twelve nuts it was possible to separate a little more than three grains of proteose by the usual method. The average of three closely agreeing determinations of nitrogen was 18.57%; of the ash it was 1.71%. The quantitative relationships of these and other constituents will be subjects of combined investigation.

Dr. Curtis drew attention to the irritation of the mucous membrane of the bladder and urethra caused by drinking too freely of cocoanut milk. Dr. Gies, in answer to a question, stated that the food content of the cocoanut is small.

'The significance of Carbohydrates in Muscle,' by Frederic S. Lee and C. C. Harrold.

This work is a continuation of the senior author's study of the nature and causes of muscle fatigue. Of the two supposed causes of fatigue, loss of substance necessary to contraction and poisoning by so-called fatigue products, the present work deals with the former. It is well known that the drug phlorhizin causes the removal of the carbohydrates from an organism to which it is administered. The authors find that it induces decided evidences of fatigue in the muscles of fasting cats. A well phlorhizinized muscle is comparable to a normal muscle in the late stages of fatigue. This effect seems to be due, not to a specific action of the drug on the protoplasm of the muscle cells, but to the loss of carbohydrate from the muscle. This conclusion is rendered probable by the fact that when an animal has been put well under the influence of phlorhizin, the administration of sugar (dextrose) counteracts the effect of the drug, removes the evidences of fatigue and restores the muscle. It seems probable that the loss of carbohydrate is an important factor in the early stages of muscle fatigue.

Incidently some observations on rigor mortis have been made. A muscle well under the influence of phlorhizin may begin to go into rigor five minutes after death and rigor is complete very early. This confirms the conclusions of others that there is a close connection between rigor and carbohydrate. A muscle irrigated with dextrose is capable of giving fully as many contractions as, or even more than, a normal muscle without dextrose.

The election of sectional officers resulted in the appointment of Professor C. L. Bristol, of the New York University, as Chairman, and Professor F. E. Lloyd, of Teachers College, as Secretary for the ensuing year.

F. E. Lloyd,
Secretary.

TORREY BOTANICAL CLUB.

At the meeting of Wednesday, April 25, 1900, the paper of the evening was by Mr. David Griffiths, 'Some Saprophytic Fungi.' Mr. Griffiths described the mechanical devices employed by the genera of the Pyrenomycetes for the distribution of their spores. The genera described with reference to this point were *Podospora*, *Sordaria*, *Deletschia*, and *Sporomia*.

In *Podospora* the ascus elongates to the apex of the perithecium, where it is ruptured and the spores are scattered.

The genus *Sordaria* distributes its spores in the same manner but with a definite point at which the ascus ruptures.

The methods of ejection in the case of the other two genera, are very similar, except in the details of the rupture of the internal membrane of the ascus; here the membrane elongates instead of the ascus itself.

The meeting of Tuesday, May 5, 1900, was held in the lecture hall of the Museum building at the New York Botanical Garden, with a lecture by Dr. M. A. Howe, on 'The Hepaticæ.' The term *Hepaticæ* was used in a restricted sense, excluding the Anthocerotes.

After a few introductory remarks in regard to the position occupied by the *Hepaticæ* in the vegetable kingdom, the speaker reviewed the life-history of a few of the typical forms, the principal details of structure being exhibited by aid of lantern slides. The slides also showed the habit characters of various local species and of some from the Pacific coast.

Though the *Hepaticæ* are on the whole inconspicuous, and attract little attention except from the botanical specialist, they are nevertheless extremely diversified in structure and often very beautiful in form. Their chief interest, however, to the naturalist lies in the fact that many of them throw light upon questions concerning the evolution of the plant world. The first plants, without doubt were purely aquatic in habit of life. The *Hepaticæ*, though favoring moist situations as a class, range from species which are wholly aquatic to those which have become adapted to quite arid conditions.

As a group they may be considered to be the lowest of the chlorophyll-bearing land plants.

J. K. Small,
Sec'y Pro. Tem.

DISCUSSION AND CORRESPONDENCE.

THE STUDY OF GREEK AND LATIN *vs.* MODERN LANGUAGES.

IN his discussion in SCIENCE of May 25th, of the question: 'Should Greek and Latin be required for the degree of Bachelor of Arts,' Professor Stevenson seems to me to slight some points that bear essentially upon the merits of the question, at least so long as the methods and subjects utilized in teaching the modern languages are not materially changed. As matters now stand, I think it may fairly be claimed that, *as a matter of fact*, the bulk of graduates omitting Latin and Greek from their curriculum, are usually found sensibly deficient in broadness of general culture, when placed alongside of graduates from a 'classical' course. As one who has had special occasion to make the comparison, I should rarely choose, outside of scientific discussion, the social companionship of those educated only in the lines of sciences and modern languages, as now commonly carried out.

That as broad an education *can* be given through the modern languages as through the ancient ones, I fully agree, even though I cannot but think that the more complete grammar of the latter imparts a kind of mental training not easily duplicated by the study of German and French; while the deficiencies of the English language in grammatical forms, however, conducive to its adaptation as a world-language, leaves one who knows *it* alone, peculiarly ignorant of language-structure in general, and hardly capable of a critical understanding of even English literature.

But even admitting that translations of the ancient classics into the chief literary modern languages afford satisfactory access to the writings of the ancient authors through which the civilizations that have so largely shaped our own have been transmitted to us, the fact is that these translations are practically never used in the 'new' education. Wilhelm Tell and Maria Stuart, with a few of the easier prose writings of Goethe, Lessing and others, form the standard works the student sees after he 'absolves' the German readers; in French, Telemaque constitutes, as a rule, the sole book read that has any reference to classic antiquity. It is true that the student *can* subsequently read the translations of the classics; but not one in a hundred does so. The result is that not only bachelors of arts, but even masters of the same, and, sad to say, even some modern doctors of philosophy, are found to be blissfully ignorant of the fact that the Greeks and Romans ever did anything which an enlightened modern scientist is bound to respect. With the bare smattering of history brought from the high school, dimmed by a crowded four-years curriculum, the bachelor too commonly emerges with the impression, if not conviction, that modern time and its brilliant scientific and industrial achievements, is really all that is worth considering. Frequently even the history of his own special science is wholly unfamiliar to him, as may be but too frequently observed in the case of those who have graduated on the basis of 'organic' chemistry, and pride themselves upon their ability to produce new compounds by the score, with the exact structure-formulæ in black-and-white, but who barely remember, in a general way, such names as Lavoisier, Davy, and Berzelius, much less what their science owes to these men.

Certainly such ignorance of the history of man, political, philosophical and scientific, as we already so commonly find in the modern college graduate, is a most serious evil; conducing as it does to a one-sided view of life, and especially to that overweening self-esteem which is not only socially offensive, but vitiates effective scientific work, by the failure to co-ordinate it with that of those who have preceded in similar lines of study. To avoid this narrowness, then, it would be necessary to revise materially the kind and scope of reading done by bachelors of arts in the modern languages.

Freedom of election of studies is a very seductive watchword; but freedom without corresponding intelligence to make beneficial use of it is a delusion and a snare, in education as well as politically—as this nation has abundant reason to know. One of its not altogether happy results is the proverbial American youth, of both sexes, whose precocity and brightness is but too generally associated with a lack of reverence ('veneration,' *phrenologice*) between which, and the extreme repression of youthful exuberance in the earlier stages of European education, the choice is frequently painful. It is to be hoped that means may be found to establish a happy mean between the two; but it is quite certain that among the subjects of education conducive to that end, the history of the intellectual evolution of mankind must find a more conspicuous place than is assigned to it in the latest scheme of higher education. The titles bachelor and master of arts should, in my view, together with the doctor of philosophy, remain the badge of such broader education; and those who are content with narrow lines should also be content to receive only a corresponding degree. E. W. Hilgard.

University of California.

PHOSPHORESCENCE IN DEEP-SEA ANIMALS.

It is stated, among others, by Beddard in his animal coloration that the brilliant and varied colorations of deep-sea animals are totally devoid of meaning, either by way of protection or warning, for the simple reason that not enough light penetrates to the depths of the sea to permit them to be visible. But in a paper on the 'Utility of Phosphorescence in Deep-Sea Animals,' in a late number of the *American Naturalist*, it is maintained by C. C. Nutting that the quantity of phosphorescent light emitted by the animals of the deep sea is very considerable—so great, in fact, as to supply over definite areas of the sea bottom a sufficient illumination to render visible the colors of the animals themselves. This lighting up of the depths of the sea would be of manifest benefit to the various animals which combine to bring it about—it would serve much the same purposes as protective, aggressive, alluring and directive colorations. For the free-swimming animals—fishes, crustaceæ, molluscs, part of the cœlenterates, most of the protozoa—the utility of phosphorescence is the more readily obvious; but since practically all deep-sea forms live exclusively on animal food, and since it is well known that light exerts a strangely attractive power on widely different forms of animal life, the fixed species would also enjoy at least the benefit of attracting their prey. A very large number of crustaceans are phosphorescent, often brilliantly so; many of them have large eyes and are particularly active in movement and voracious in appetite; they feed on minute organisms for the most part, and it can hardly be doubted that they often use their phosphorescent powers for the purpose of illuminating their surroundings and revealing their prey. Certain cephalopods secured by the *Challenger* have been made out to have a highly specialized apparatus designed to reflect light from their phosphorescent bodies downward to the bottom over which it passes; in this case there is not only light but also a reflector, an efficient bull's eye lantern for use in hunting through the abyssal darkness.

Among the ctenophores and medusæ we encounter amazing displays of the 'living light'; as these animals have eye-spots, and seem to be able to distinguish light, their phosphorescence may serve to keep them together in groups and thus effect the same end as directive coloration among vertebrates and insects. It is important to note that blind species of groups normally possessed of eyes are seldom if ever phosphorescent. Noctilucca and other allied Protozoa are often found at considerable depths, and hence come under the head of deep-sea forms, but they differ from the organisms already mentioned in having no recognized organs of sight, and also in an extreme simplicity of organization. They, however, occur in enormous swarms and hence must have some means of keeping together, and moreover, they have been proved to be, although eyeless, extremely sensitive to light. In fact, it is practically certain that sensitiveness to light is a fundamental property of simple protoplasm. It is easy to conceive, therefore, that in these little creatures their phosphorescence is directive in function; the same thing is doubtless the case with a medusa of the subtropical Atlantic, which thickly covers hundreds of square miles of surface, and which glows like a living coal at night. C. L. Franklin.

Baltimore, Md.

CURRENT NOTES ON METEOROLOGY.

BALLOON METEOROLOGY.

The rapid development of what may well be called balloon meteorology has resulted in the publication of a large number of articles on this subject within the last four or five years. Indeed, the number of publications has been so large that it has been difficult even for the student of meteorology to keep up with the literature. We now have an octavo pamphlet of 161 pages, entitled *Beiträge zur Erforschung der Atmosphäre mittels des Luftballons* (Berlin, Mayer und Müller, 1900. Price, 4 Marks), which will serve well as an introduction to the study of the most recent work done in balloon meteorology. This report is edited by Dr. Assmann, and has chapters by Berson, Gross, Kremser and Süring—all of them men who have been closely associated with scientific ballooning in Europe. Dr. Assmann contributes an introduction and a chapter on the equipment needed on a scientific balloon voyage. The others have prepared chapters on the various ascents between March 1, 1893, and February 15, 1895. An appendix contains tables showing the most noteworthy data in connection with the ascents from February 15, 1895, to the end of 1899. This book is a striking illustration of the rapidity with which the investigation of the upper air by means of balloons has progressed. Record is given of 77 ascents.

ERRORS IN SCHOOL BOOKS.

IN a recent number of the *Monthly Weather Review*, Professor Abbe calls attention to the fact that the geography adopted by the Legislature of Montana for use in the public schools of that State contains the following remarkable statement: "The warm winds known as the chinook winds, from the Pacific, heated by the Japan current, may spring up even in the coldest weather." This view as to the source of warmth of the chinook winds is entirely erroneous, just as is a similar view formerly commonly held in regard to the warmth of the Swiss *foehn*, viz, that that wind, coming down warm and dry in the northern Alpine valleys, has its origin in the desert of Sahara. The warmth and dryness of chinook and foehn are the result of the warming by compression of the descending air, as was very fully explained by Hann, in the case of the *foehn*, some years ago. It is a serious thing to have children in the public schools of one of our States taught any doctrine so erroneous as that which refers the warmth of the chinook to the Kuro Siwo.

THE CLIMATE OF NEW YORK STATE.

A RECENT number of the *Bulletin of the American Geographical Society* (No. 2, 1900) contains an article on the climate of New York, by E. T. Turner, which gives an excellent presentation of the chief climatic features of the State. The article is largely a reprint of a report upon the same subject by Mr. Turner, originally published in the *Fifth Annual Report of the Meteorological Bureau and Weather Service of the State of New York* (Albany, 1894, pp. 347–457). Several new charts have, however, been added, including some typical barograph and thermograph curves, and two thunderstorm charts. It would be well if similar condensed reports upon local climates were available for our other States.

LOSS OF LIFE BY LIGHTNING IN 1899.

ACCORDING to A. J. Henry (*Monthly Weather Review*, March, 1900) the loss of human life by lightning in the United States during the year 1899 was greater than in any preceding year for which statistics have been collected. The number of persons killed outright, or who suffered injuries resulting in death, was 562, and the number of those who received injuries varying in severity from slight physical shock to painful burns and temporary paralysis of some part of the body was 820. The greatest number of fatalities (45 per cent.) occurred in the open; the next greatest number (34 per cent.) occurred in houses; 11 per cent. occurred under trees, and 9 per cent. in barns. At least a dozen persons were killed either in the act of stripping clothes from a wire clothes-line, or by coming in proximity thereto during a thunder storm.

RECENT PUBLICATIONS.

Studies of Cyclonic and Anticyclonic Phenomena with Kites, by H. H. Clayton. Second Memoir. Blue Hill Meteorological Observatory, Bulletin No. 1. 1900. 4to. Pp. 36. Pls. IV. This is Mr. Clayton's second Bulletin on the theory of cyclones and anticyclones as viewed in the light of the Blue Hill kite records. The author holds that a modified convectional theory, rather than the Hann, or driven, theory, best explains the facts discovered.

Anales de la Oficina Meteorologica Argentina, por su Director, Gualterio G. Davis. Tomo XII. *Climas de Asuncion del Paraguay y Rosario de Santa Fe.* Segunda Parte: *Discusion de las Observaciones hechas en Asuncion y Rosario.* 4to. Buenos Aires. 1898. Pp. 297. This is one of the valuable series of publications on the climate of the Argentine Republic which is being issued by Mr. Walter G. Davis, the Chief of the Argentine Meteorological Service.

R. DeC. Ward.
Harvard University.

CURRENT NOTES ON PHYSIOGRAPHY.

PHYSIOGRAPHY OF MARYLAND.

'A General Report on the Physiography of Maryland,' a dissertation by Cleveland Abbe, Jr., for the degree of doctor of philosophy at Johns Hopkins University (Maryland State Weather Service, i, 1899, 41–216), stands with the account of Missouri by Marbut, of New Jersey by Salisbury, and of New York by Tarr as one of the few thorough studies of State geography that have yet appeared in this country. Many items of interest might be abstracted from it. For example, those concerning the lower courses of the 'falls' or young cascading streams in the narrow gorges by which the Piedmont plateau is dissected for eight or ten miles inland from the fall-line, and the upper courses of the same streams which flow quietly through shallow open upland valleys where the effects of the elevation of the region are not yet felt. Again, those concerning the Hagerstown (Appalachian) valley, a well-finished and evenly uplifted peneplain, now rather sharply dissected by young streams in narrow meandering gorges, from which it is inferred that the streams meandered upon the valley floor before uplift of the region to its present altitude (500 feet in the neighborhood of the Potomac). A chapter on the development of the streams of the Piedmont plateau bears evidence of the greatest proportion of original study; it leads to the conclusion that the streams east of Parr's ridge (which represents a low swell surmounting the former lowland of the Schooley peneplain) have been superposed through a cover of coastal plain strata that once extended further inland than now.

An introductory account of 'Physiographic Processes' contains a paragraph which may mislead by stating that the ridges of the Appalachian province have been 'formed by the folding and faulting of the paleozoic strata of that district.' A learner might thus be tempted to compare them with the young unsculptured mountain blocks of southern Oregon; yet, as indeed appears from other pages of the Report, the Appalachian ridges of to-day are as truly forms of circumdenudation as are the low hills of the coastal plain or the high hills of the Allegheny plateau.

THORODDSEN ON ICELAND.

Thoroddsen has prepared a most interesting summary of his eighteen years of exploration in Iceland (*Geogr. Journ.*, xiii, 1899, 251–274, 480–513). The island, 40,450 square miles in area, is the dissected remnant of a basaltic plateau, averaging 2000 feet in altitude, and for the most part barren and uninhabitable. Non-marine tertiary strata are intercalated within the basalt sheets, and a 'pelagonite breccia'* overlies them on a third of the surface. Deep valleys and fiords have been eroded in the margin of the plateau, where coast cliffs rise 2000 or 3000 feet; but in the interior the relief is less pronounced. Relatively modern lavas have been poured out abundantly on the plateau, building mountains, filling valleys, displacing rivers and altering the coast line. Of 107 volcanoes counted in a certain district, 8 were large lava and ash cones of the Vesuvian type, 16 were large flat domes of the Mauna Loa type, and the remainder were small ash cones arranged in chains along fissures. The summits of the domes, 2000 or 3000 feet in height over the plateau, are broken by large craters (calderas?) containing frozen lava lakes; many lava tunnels are found on the slopes of the domes, whose inclination is seldom more than 7° or 8°, and may be much less. The small ash cones may be as steep as 30° and occasionally 40° or even 50°: one chain contains

*This formation has lately been interpreted as of ancient glacial origin by H. Pjetersson. *Scot. Geogr. Mag.*, xvi, 1900, 265–293.

100 such cones along a 20 mile fissure. At some points, the lava has flowed quietly from fissures without forming cones or craters. Lava sheets and streams, sometimes scores of miles in length, are as barren as the domes of ice and snow. The more viscous flows have steep borders, so that they rise in ragged ridges, impassable from being covered with loose clinkery fragments. The more fluid flows have formed smooth and nearly level fields, except that their surface is here and there disturbed by irregular subsidence, or broken by great cracks which turn back the traveler. Secondary craters are numerous on certain flows, sometimes to the number of hundreds crowded together, as if the flow had run over a marsh or lake. Parts of the plateau are covered with drifting sand, swept about in blinding storms. The whole island has been deeply covered by an ice sheet (except where an occasional volcanic cone rose as a 'nunatuk' or island), as is proved by abundant striations, morainic deposits and transported boulders, save over some 5000 square miles where the glaciated surface has been buried under the more recent lavas. Lakes of glacial origin are numerous. Sheets of ice and snow to-day cover about an eighth of the island area, mostly as mantles over the domes of the plateau from which a few glacial arms descend to lower levels.

The lowlands are of small extent. They consist of narrow coastal plains (strips of sea bottom revealed by recent elevation) or of fluviatile plains built forward by waste-laden glacial rivers. Two elevated shore lines on the inner margin of the coastal plains stand at heights of 250 and 125 feet, marked by cliffs, caves and beaches; the strata of these plains contain marine shells. The fluviatile plains or 'sandr' are chiefly developed on the southern coast, where the rainfall is two or three times heavier than in the north. Here one finds all the phenomena of aggrading braided rivers; a single glacial torrent may, on emerging from the highland, split into a hundred shifting channels, with islands of sand and clay occupying the meshes of the network. The rivers are exposed to 'ice-floods' when the glaciers of the highland domes are melted by volcanic heat; overwhelming turbid torrents then bear huge ice fragments and abundant rock waste down to the sea. The southern coast has been rendered harborless by the growth of the 'sandr,' and the shore is frequently bordered by off-shore sand reefs, built by the heavy surf. Elsewhere the coast is extremely irregular, bold headlands projecting between long fiords, into which the streams from the uplands fall in high cascades. Rivers of clear 'mountain water' have not yet formed important delta plains; but where the rivers bring down 'glacial water,' the fiords are shoaled and extensive delta plains occupy their heads.

Settlements are limited to the lowlands, where the people pasture cattle and sheep on the plains, catch birds on the cliffs, and take fish from the sea. But besides suffering the disadvantages of an inclement climate, the lowlands are exposed to lava floods which bury the fields, to river floods which lay them waste, and to ash showers which poison the pastures, causing famine and death to beast and man. It is indeed curious that a people brave enough to discover distant Iceland in a stormy sea, hardy enough to inhabit it for a thousand years, and intelligent enough to develop a remarkable literature, should not have had enterprise enough to leave the island for a more favorable home. Evidently the world is not in the 'free market' that the older economists supposed.

W. M. DAVIS.

SCIENTIFIC NOTES AND NEWS.

ABERDEEN UNIVERSITY, at its graduation ceremony, conferred the degree of Doctor of Laws on Professor Josiah Royce, of Harvard, who had recently completed the second series of Gifford Lectures before the university.

PROFESSOR D. A. KENT, of the Iowa State Agricultural College has been appointed by the Sultan of Turkey, instructor of farming for the Turkish Empire.

PROFESSOR M. B. BRUMBAUGH, who holds the chair of pedagogy at the University of Pennsylvania, has been offered the office of Superintendent of Instruction at Porto Rico. It is understood that he will accept if he can secure a leave of absence of four years from the University.

Professor Ernst Haeckel has been elected an honorary member of the Academy of Sciences at Bucharest.

The Literary and Philosophical Society of Manchester has elected the following honorary members: Professor James Dewar of the Royal Institution, Professors A. Ewing and A. R. Forsyth of Cambridge University, Professors Ernst Haeckel of Jena, and H. A. Lorentz of Leiden, Mr. Robert Ridgeway of Washington, and Mr. Beauchamp Tower of London.

Professors Joseph Le Conte and William Carey Jones, of the University of California, have been granted a year's leave of absence from the University which they will spend abroad.

Professor Macfarlane, of the State Normal College, Ypsilanti, Mich., has returned from Vienna, where he has been studying geology for the past year with Professor Penck. During the autumn months he will be at Harvard University, carrying forward his studies with Professor Davis.

Dr. Charles F. Chandler, professor of chemistry in Columbia University, president of the Society of Chemical Industry, which meets next month in England, sails for England on June 16th.

Professor George F. Sever, of Columbia University, has accepted the position of superintendent of electrical exhibits of the Pan-American Exposition.

Miss Mary H. Kingsley has died at Simonstown, South Africa, where she had been superintending the arrangements of the military hospitals. Miss Kingsley, who was the daughter of Dr. G. H. Kingsley and a niece of Charles Kingsley, made in 1893 and in 1896 journeys through little known parts of Africa and published accounts of her explorations in two interesting volumes 'Travels in West Africa' and 'West African Studies.' She also made valuable botanical collections in St. Paul de Loanda, Old Calabar and the region of the Niger coast protectorate.

Mr. G. F. Göransson who made important improvements in the Bessemer process for making steel has died in Sweden at the age of 81 years.

We also regret to notice the death at the age of 77 years of Mr. James Thomson of Glasgow, known for his geological work especially on Scottish carboniferous corals.

Mr. Willard N. Clute, editor of the *Fern Bulletin*, has returned from Jamaica with several species of plants that were unknown to science. He will probably return for more specimens. In the eastern part of the island away from the cities he saw but few remains of prehistoric peoples. The present natives often bury their dead in their own front yards, erecting over each grave a rectangular structure of brick and mortar the size of the grave and about two feet high. This is covered with a large flat stone or stones. The negro folk-lore of Jamaica is being recorded by Mr. Edward S. Earle, of Kingston.

President Jordan and Mr. John O. Snyder, of the Department of Zoology in Stanford University sailed June 6th on the steamer *Gaelic*, for the purpose of making a collection of the fishes and insects of Japan. They will be assisted in Japan by S. Kuwana, an assistant in entomology at Stanford, who sailed to his native country on an earlier steamer, by Keinosuke Otaki, a graduate of Stanford, now teacher in a royal military academy in Tokyo, and by James F. Abbott, also a graduate of Stanford, now teaching in a governmental school at Otsu. The expedition is under the patronage of Mr. Timothy Hopkins, founder of the Hopkins Seaside Laboratory at Monterey. It is hoped that a full survey of the fish fauna of the islands may be made, and generous collections of other forms of life are expected.

G. B. Gordon, who has charge of the explorations to be made at Copan, has secured from President Sierra of Honduras, for Harvard University, by treaty arranged at Tegucigalpa on February 22d, the control of the ruins of Copan and the lands pertaining thereto, for a period of ten years, with the right to make excavations and to remove to Cambridge for preservation a portion of the objects that may be found.

It is stated in *Nature* that Mr. J. S. Budgett has left Liverpool on his second expedition to the Gambia, where he is going in order to complete his studies of the fish-fauna of that colony, and especially to investigate the life-history and development of the abnormal fishes *Polypterus* and *Protopterus*. On reaching Bathurst, Mr. Budgett will proceed up the River Gambia to his former quarters on M'Carthy's Island, in the neighborhood of which he has already ascertained that these fishes are found breeding during the rainy season. A paper on points in the anatomy of *Polypterus*, based on specimens obtained by Mr. Budgett during his first expedition, was read before the Zoological Society on May 8th, an abstract of which we published recently.

PROFESSOR W. M. DAVIS of Harvard University, Professor R. E. Dodge of Teachers College, Columbia University, and several other geologists are engaged in making an exploratory trip through the Grand Canyon of the Colorado.

THE Royal College of Surgeons of England will, as we have already announced, celebrate its centenary at the end of July. The exercises will begin with a *conversazione* at the College on the evening of Wednesday, July 25th. On Thursday morning Professor Stewart, F.R.S., the conservator, will give a demonstration in the Hunterian Museum. On the afternoon of the same day a general meeting will be held in the theatre of Burlington House, when the President, Sir William MacCormac, will deliver an address, and honorary fellowships will be conferred. In the evening a festival dinner will be held in the great hall of Lincoln's Inn. On Friday morning Professor Stewart will again give demonstrations, and on the evening of that day a *conversazione* will be given by the Lord Mayor at the Mansion House.

A DESPATCH to the daily papers states that an explosion occurred in the mechanical laboratory at the Agricultural College, at Lansing, Mich., on June 5th, while Professor M. D. Atkins was conducting an experiment in the presence of the students. Professor Atkins was seriously burned, and the sight of his left eye was destroyed by flying particles of glass. H. D. Hornbeck, a student, who was assisting, was also badly burned, and it is feared he will lose his right eye.

M. CREVAT-DURAND, of Fontainbleau, has by his will made generous public bequests, including 150,000 frs. to the Paris Pasteur Institute. The addition to the Institute, which comprises a hospital and laboratories for biological chemistry, is now complete.

THE difference between the Senate and the House of Representatives in regard to an appropriation for the Hydrographic Bureau of the Navy Department, which created special interest and prevented the adjournment of Congress at the expected time was compromised by giving $50,000 to the Bureau for Ocean Surveys, but providing that the survey should not be extended to the coasts or inland waters.

M. MASPERO, the new *directeur des antiquités et des fouilles en Egypte*, in a paper before the *Académié des Inscriptions et Belles-lettres*, explains a long hieroglyphic inscription containing fourteen engraved columns. This granite stele was found at Kem-gayet on one of the estates of Husseinpacha, uncle of the Khedive, and was presented immediately to the Gizeh Museum. It represents the king Nectanebo II., the last pharao of the native dynasties and bears the date of the reign. Nectanebo is making an offering to the goddess Nel de Saïs in gratitude for benefits received at her hands.

DR. THEODORE BEER, whose valuable studies on the sensory organs of both vertebrates and invertebrates are well known, is engaged in writing a comprehensive work on the *Comparative Anatomy and Physiology of the Organs of Vision*, and to make this as complete as possible he is anxious to acquire separates of all articles —for which, if desired, he will send his own writings in exchange—dealing in any way whatever with the anatomy, embryology, zoology, pathology, or literature of the organ of sight in animals or the eye of man, or with reactions to light. Dr. Beer is particularly desirous that none of the widely scattered writings of Americans should escape his attention, and therefore especially invites the co-operation of all Americans who can aid him. Communications should be addressed: Dr. Theodore Beer, *Privatdocent für vergl., Physiologie a. d. Universität*, Anastasius Grün-Gasse 62, Wien, XVIII, Austria.

UNIVERSITY AND EDUCATIONAL NEWS.

Columbia University has received an anonymous gift of $100,000 for a building to be devoted to the religious life of Columbia, like Dwight Hall, at Yale, and Brooks House, at Harvard.

Mr. J. B. Duke, of Durham, N. C., has presented Trinity College, of that city, with $50,000 for a library.

It is said that President Taylor will be able to announce at the Vassar commencement, that the $25,000 needed for a biological laboratory in addition to the $25,000 given anonymously, has been secured, and that the building will be erected without delay.

By the death of Mrs. Juliet S. Bradford, half the estate of Dr. Vincent L. Bradford of Philadelphia, who died sixteen years ago, reverts to Washington and Lee University. The University will receive $100,000 and the testator's law library and paintings. The amount is still charged with several annuities, and by the terms of the will the paintings and the law library are to be kept up by the annual appropriation of $500 and $400 respectively.

It is planned by a corporation composed chiefly of friends of Teachers College, Columbia University, to purchase a site and erect a dormitory for the College on the Amsterdam avenue front of the College block. The approximate cost is estimated at $1,000,000.

A new chair of physics, the Wykeham professorship, has been established at Oxford, and steps are being taken to establish a special laboratory in connection with it.

The wood-working shop and men's gymnasium of the University of Illinois were destroyed by fire on June 9th.

A freshman at Harvard University has been sentenced to five days in jail by Judge Almy for stealing a sign, which appears to be a sensible way to put a stop to such minor breaches of the law among college students.

Professor F. P. Venable, Ph.D., F.C.S., director of the chemical laboratory in the University of North Carolina, was on June 5th unanimously elected to the presidency of that institution. He succeeds Dr. E. A. Aldemann, who, as we have already reported, goes to Tulane University as president.

Nathan R. Leonard, who for twenty-seven years has been professor of mathematics in the State University of Iowa, has been elected president of the Montana School of Mines, at Butte.

At the University of Pennsylvania Dr. J. William White Rhea Barton has been appointed professor of surgery, and Dr. Edward Martin and Dr. Charles S. Frazier clinical professors of surgery. Dr. Richard M. Pierce was made demonstrator of pathology, and Dr. William F. Hendrickson and Dr. Frederick H. Howard assistant demonstrators in pathology.

Dr. F. L. Dunlop leaves the Worcester Polytechnic Institute to accept an instructorship in Chemistry at the University of Michigan.

Professor Robert B. Owens, of McGill University, has been appointed to the Tyndall fellowship in physics of Columbia University, and Mr. J. A. Matthews has been appointed Barnard fellow.

At the University of North Carolina, J. E. Mills, A.B., A.M. (Davidson College N. C.), has been made assistant in chemistry, and J. E. Latta, Ph.B. (University of N. C.), instructor in physics.

Dr. Max Meyer, formerly assistant in the psychological laboratory at Berlin and this year honorary fellow in psychology in Clark University, has been appointed professor of psychology in the University of Missouri. Dr. Charles W. Green has been appointed instructor in zoology in the same University.

Mr. J. Frank Messenger, B.A. (Kansas, 1895), has been appointed assistant in the psychological laboratory of Harvard University.

We notice the following appointments in German Universities: Dr. Alfred Wohl docent in chemistry at the University of Berlin, has been promoted to a professorship; Dr. A. Fritsch of Vienna, has been appointed associate professor of botany in the University at Gratz; Professor Eugen Meyer of Göttingen, has been made professor of mechanics in the Institute of Technology at Charlottenberg, and Dr. Schmeisser of Klausthal, director of the Geological Institute of the School of Mines at Berlin.

SCIENCE

FRIDAY, JUNE 22, 1900.

CONTENTS:

THE NEW YORK MEETING OF THE AMERICAN ASSOCIATION.

THE annual meeting of the American Association for the Advancement of Science is the chief scientific event of the year, and the meeting about to open in New York promises to be one of the most important in the history of the Association. This is guaranteed by the fact that some fifteen special scientific societies, a considerably larger number than ever before, meet with the Association, and it is definitely proved by the programs issued in advance by most of the sections and by some of the independent societies. These show that the most active men of science from all parts of the country will be present to report upon the results of their most recent researches and to take part in the discussions. It is certainly not only the duty, but also the privilege of those interested in science to use all possible efforts to be present at the meeting.

Those familiar with the history of modern science will realize the difficulties that must be met by an association seeking the advancement and diffusion of science as a whole. The question was comparatively simple when the Association was organized in 1848. Then and until 1875 the members could meet in one body and in the earlier period at least each could have an intelligent understanding of all the work presented. During this period too there was a general popular interest in science.

The applications of the principles of physics and chemistry to the living body, and the development of the doctrine of evolution awakened a lively interest, as they seemed to many to controvert not only generally accepted doctrines but even religion itself. But as heat was converted into light, as science found its due place in education and in modern life and settled down to the steady routine of laboratory and field, as each science became technical and required for economy and accuracy a special terminology, not only was there a decrease in popular interest, but the workers in one department could not be expected to be familiar with science as a whole.

The American Association has naturally reflected the progress of science. At the meetings held at Buffalo and Burlington at the close of the civil war there was an attendance of only about seventy-five members. Then the Association steadily grew until the meetings at Boston (1880), Montreal (1882) and Philadelphia (1884) were attended by about one thousand members. A stationary condition or perhaps a decline then occurred, which seems to be explained by increasing specialization and decreasing popular interest. These conditions are now being met by an adjustment to the altered environment. In 1875 separate sections were organized for the physical sciences and for natural history, and in 1882 nine sections were established, but it was not until 1893 that botany was separated from zoology. In the meanwhile separate societies have been organized for nearly all the sciences, meeting the needs of modern specialization. Some of these societies, not finding a proper place in the Association, have joined in a Christmas session, but others have chosen the time and place of the meeting of the American Association. At first it was feared that these special societies would injure the parent Association, but it was found that the simultaneous meeting of the American Chemical Society made the section for that science the strongest in the Association. The many special societies meeting this year in New York will probably bring together more men of science and contribute more to the advancement of science than any scientific gathering ever held in America. At the same time the membership of the Association will be larger than it has ever been before.

With the approval of the Council, the local committee for the New York meeting has confined its attention to arranging for the scientific work of the sections. There is much to be said for leaving the general arrangements for the meetings in the hands of a central administration and the cost to the Association, and for abolishing free luncheons, free excursions, etc. Missionaries may be fed on charity, but business men prefer to pay their own bills. The Association can no longer hope to carry science to the houses of the people, at least not in a city such as New York, but meets to promote its own interests and the interests of its members. The fact that these interests are identical with the interests of society is certainly a reason for satisfaction and pride and should lead to the conduct of the meeting with added dignity.

The fact that the Association will be welcomed to New York by the local members rather than by the citizens of the city and that the excursions will be scientific rather than sight-seeing in character will probably not detract from the social intercourse which is one of the important functions of such meetings. Men of science wish to see and hear each other rather than on-lookers and outsiders, and they are competent to decide what they wish to see in a city such as New York. The headquarters at the Hotel Majestic overlooking Central Park, is within convenient reach of Columbia University and the American Museum of Natural History, where the sessions will be held. There are in the neighborhood of the University numerous good boarding houses, now empty owing to the absence of students during vacation. The situation of the University with pleasant grounds overlooking the Hudson river, promises reasonable freedom from heat and dust, and ample accommodation both for social intercourse and scientific work.

The Association will be welcomed to Columbia University by President Low, long a member, at eleven o'clock on the morning of Monday, June 25th, and after brief addresses by the retiring president, Mr. G. K. Gilbert and the president-elect Professor R. S. Woodward, the members will separate for the organization of the Sections. On Monday afternoon five of the vice-presidents, Professor Asaph Hall, Jr., Professor Ernest Merritt, Professor Jas. Lewis Howe, Professor J. F. Kemp and Professor William Trelease, will give their addresses, the others being postponed until next year. President Gilbert will give his address at the American Museum of Natural History on the evening of June 26th. Various scientific excursions have been arranged by the different sections, which will be part of their scientific work. A meeting in New York City under the conditions described and at the end of June is certainly an experiment worth making, and there is every reason to believe that it will be successful.

PROGRESS OF THE NEW YORK ZOOLOGICAL PARK.

AMONG the attractive features of the coming meeting of the American Association in New York are the proposed visits to the Botanical Garden and the Zoological Park. These sister institutions are developing rapidly in the northern and southern portions of Bronx Park and both deserve careful study, even in their present unfinished condition. Members of the Association desiring to see both parks on the same day will do well to take a Harlem train direct to Bedford Park, walk through the Botanical Garden and buildings eastward to the Bronx river, then southward along the line of the river to the Boston road entrance of the Zoological Park to the northwestern entrance, returning to New York by the Fordham station of the Harlem railroad. Members desiring especially to see the Zoological Park should take the train from 42d street or 125th street to Fordham.

The following extracts from the Fourth Annual report recently issued by the Zoological Society will give some idea of the present state of development of this project. The Zoological Park was formally opened to the public on November 8, 1899; Professor Osborn delivered the address of welcome on behalf of the Society and the Park was formally accepted by Comptroller Coler. During the inclement months of November and December it was visited by 90,000 people; the present attendance on holidays and Sundays averages between 15,000 and 17,000; the attendance since January 1st is 294,000. The Park is thus a thoroughly popular institution. The membership has risen to over 850 and is slowly increasing; a vigorous attempt is being made to raise the membership to 3000, and thus provide an income which will constantly renew the supply of animals and enable the Society to erect a building every other year.

Up to the present time $10,000 has been expended in the purchase of animals and about $200,000 in the construction of buildings and other installations. The following ranges and installations are now complete:

Mule Deer Range, Fallow Deer Range and House, Axis Deer Range and House, Ducks' Aviary, Flying Cage, Aquatic Birds' House, Black-tail Deer Range, Virginia Deer Range, Red Deer Range and House, Moose Range and House, Wapiti Range and House, Wolf Dens, Fox Dens, Aquatic

Mammals' Pond, Otter Pool, Antelope Range and House, Prairie Dogs' Enclosure, Burrowing Rodents, Small Mammal House (temporary), Wild Turkeys' Enclosure, Reptile House, Crocodile Pool, Bear Dens, Beaver Pond, Buffalo Range and House.

The Aquatic Bird House is very attractive with a large interior flying cage and an aquarium for diving birds. Adjoining the building is the Ducks' Aviary and the large Flying Cage, which it is hoped to complete before the visit of the Association. The Reptile House is the first of the larger type of buildings to be completed and it is a model of its kind, with an extensive display of tropical and North American reptiles. The fine Crocodile Pool and other well planned installations present a great variety and departure from stereotyped methods of exhibition.

The city has thus far expended $125,000 upon the improvement of the grounds, and recently an additional appropriation of $300,000 has been approved by the Legislature but has not thus far passed the Board of Estimate. With this fund it will be possible to render the Park one-third complete. Upon the whole, the city authorities have been very friendly towards this enterprise. The only difficulty has been the inadequate maintenance; only $40,000 has been set aside for the year 1900, whereas the Park cannot be maintained for less than $60,000 in its present state of development, and $100,000 when it is completed. As the Park derives practically nothing from gate receipts and all revenue from privileges is devoted to the purchase of animals, it is entirely dependent upon the city for maintenance, while the Society agrees constantly to supply the animals and to proceed with the erection of buildings as fast as possible.

During the past year under the able direction of Mr. Hornaday the administration of the Park has been thoroughly systematized and the service is very economical and effective. Three Assistant Curatorships have been established as follows:

J. Alden Loring, Mammals; C. W. Beebe, Birds; R. L. Ditmars, Reptiles. The Assistant Curators are energetic in their various branches and it is the intention of the Society, sooner or later, to promote them to curatorships with an increase of salary.

Great care has been exercised in the selection of animals. With the exception of a very few specimens all the animals in the Park were caught wild when young and these types are especially fine examples of their kind. The Buffalo range is supplied with 10 splendid bulls and cows from Kansas. Most of the ranges are also well supplied. On June 1st the Mammal collections of the Park were made up as follows:

	Species.	Specimens.
Primates	6	10
Carnivora	21	43
Ungulata	9	28
Rodentia	6	65
Edentata	1	1
Marsupialia	1	4
	44	151

On the same date the Reptilian collection consisted of the following:

	Species.	Specimens.
Crocodilia	1	18
Chelonia	22	85
Lacertilia	12	65
Ophidia, venomous	11	51
Ophidia, non-venomous	33	186
Amphibia	13	40
	92	445

The Bird installations are as yet far from complete; 44 species are represented by 185 specimens.

Chief attention has naturally been devoted chiefly to the raising of funds, to the work of construction and of planning the various installations, the establishment of the many new features which will characterize the future development of the Park. The endeavor throughout has been to do everything in the best possible manner, carefully studying the best models in this country and Europe and attempting to advance upon anything that has been done hitherto. Thus the Park, although far from complete, in many respects marks a great step forward in zoological park development. Most of the animals enjoy an exceptional amount of freedom. The ranges in the smaller installations are numerous and as a rule the animals are in a splendid state of health. There have been relatively few losses. The rate of growth of the animals especially in the Reptile House and the Bear Dens and in the interior Flying Cage for Birds is rapid and there is every reason to believe that most of these animals are in a perfectly normal state.

Naturally the more purely scientific work in the Society must be deferred. The field of publication has hardly been entered upon. The admirable 'Guide' which was prepared by the Director is proving very popular and has met with large sales. Illustrated bulletins describing the development of the Park have appeared only at rare intervals but it is hoped to make them more regular next winter. Considerable progress has already been made in photography and many of the photographs of living animals are not only beautiful but possess considerable scientific value as presenting perfect representations of pure types of North American and exotic animals, seen to best advantage in their natural surroundings.

HENRY F. OSBORN.

SIGMA XI, AT THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

DURING the last meeting of the American Association for the Advancement of Science, at Columbus, Ohio, the convention of Sigma Xi was held with a very large attendance, and it was decided to have a reunion of such members of the Society as might attend the meetings of the American Association at New York. It is planned, therefore, to hold a meeting at which all members of Sigma Xi are cordially invited to be present some evening during the meeting of the Association in New York. The date and hour of the meeting will be announced by posters and in the daily program.

The rapid rise of this Society in American universities is signified by the large number of young men prominent among the officers and participants in the various sections of the American Association. It was started in 1886, at Cornell University, by a few graduate students in engineering. At first the intention was to make it a purely engineering society, but soon after its organization the scope of the Society was broadened, so as to take in all the most promising men in the Senior classes giving special attention to any of the branches of science. In its extension to other institutions, it has become the representative honor-society for the ablest students of science in the institutions where it is established.

According to the constitution the object of the Society is to 'encourage original investigation in science, pure and applied.' In the report of the Committee on Extension, made at the convention of 1895, the following words express the purpose of the Society: "In establishing a new chapter * * * in each case we should make sure that we entrust the power of distributing the honor of membership only to such persons and institutions as are capable of giving the education and training necessary to the carrying on of scientific investigation; * * * we should also be well assured of the hearty co-operation of the scientific faculty in the establishment of the local chapter."

At present there are ten chapters connected with the following institutions, and the eleventh has already been voted, although not yet established:

1. Rensselaer Polytechnic, Troy, N. Y.
2. Union College, Schenectady, N. Y.
3. Cornell University, Ithaca, N. Y.
4. Kansas University, Lawrence, Kas.
5. Yale University, New Haven, Conn.
6. Nebraska University, Lincoln, Nebr.
7. Minnesota University, Minneapolis, Minn.
8. Ohio, State University of, Columbus, Ohio.
9. Pennsylvania, University of, Philadelphia, Pa.
10. Brown University, Providence, R. I.
11. Iowa, University of, Iowa City, Iowa.

In the Universities where the chapters have been established, the organization takes the place of Phi Beta Kappa among the science men, and the purpose of the organization is to recognize and associate the men of marked ability in scientific studies. The Society has been running long enough to show very clearly that there is an academic side to science, as well as to literature, and that the academic qualities promoted by scientific studies are as important as those fostered by the pure study of literature. It will be interesting to note in the course of the year to what extent the culture of the scientific qualifications of men gives them power of leadership among their fellows. It is certain that in business affairs we are already observing the important place which scientific ability takes in the really dominant men in America. If the conceptions of Sigma Xi are correct, we shall see a similar condition of leadership among the scientific scholars of the country when sufficient numbers of such scholars have been developed to overcome the precedence which we are accustomed to grant to literature as the standard of real scholarship. The chapters recently started in the University of Pennsylvania and in Brown University exhibit the enthusiasm which is already being kindled in this department of university life. The charter membership in both of these cases was composed, practically, of the whole staff of scientific professors of the university. As an honor society, it promises to take a leading part in all our universities in which science holds a prominent place.

The present officers of the Society are: *President*, H. S. Williams, Yale; *Vice-President*, S. W. Williston, Kansas; *Corresponding Secretary*, J. McMahon, Cornell; *Recording Secretary*, F. C. Caldwell, Ohio; *Treasurer*, E. W. Davis, Nebraska; *Chairman of Council*, E. L. Nichols, Cornell.

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*THE BIOLOGICAL SCIENCES AND THE PEOPLE.**

LIKE the American Association for the Advancement of Science (and other similar organizations), the Michigan Academy is an expression of the voluntary scientific activity of the people of the State, and depends for its continued usefulness on a rational interest and a helpful co-operation on the part of the people.

It has therefore occurred to me to inquire in what way the biological sciences, from whose adherents the Academy draws most of its membership, touch the people: what in the growth of these sciences makes toward and what away from a contributory interest on the part of the people. By contributory interest is meant that which aids in the upbuilding of the sciences by adding something of importance to their store of fact or theory. The question that is raised is then, not what benefit do the people receive from the biological sciences, for these are many in the practical and in the educational application of these sciences; the question is rather how may or how do the people benefit these sciences by aiding in their further growth.

I shall speak from the zoological standpoint, but what is true of zoology, is true, in this matter, in large measure, also of botany.

The question seems to be intimately associated with the recent history of zoology.

* Abstract of the address of the retiring president of the Michigan Academy of Sciences, delivered at the Lansing meeting, March 29, 1900.

The year 1859 found zoologists, the world over, working industriously and quietly at almost purely descriptive work. No more was expected of any zoologist than that he should discover and record the wonders of nature as revealed in the animal kingdom, and that he should duly express his astonishment at the infinite wisdom shown by the creator in arranging all these details. Of attempts to get at the meaning of the details there were very few. The popular notion of the zoologist's aim in life is expressed in a question that I remember to have heard asked in my student days, by a much respected professor of literature of his zoological colleague. "Well now what is that animal curious for?" In this year appeared Darwin's 'Origin of Species.' Its effect is thus graphically described by V. Graff in a recent lecture. "It came like a lightning flash in a period of quiet descriptive work, a period which had accustomed itself to consider the nature-philosophy ideas of the beginning of the century as absurd freaks of imagination, unproved and unprovable, a period which therefore clung anxiously to its foundation of facts. How the theory of natural selection put life into this dry describing, how it hurried the knife of the anatomist, and what a broad prospect it opened before the hitherto short sighted eye of the systematist! About the mummies of the species which, separated from one another by carefully formulated Latin diagnoses, filled the collections, there suddenly appeared the constricting noose of blood relationship. The petrified remains of extinct forms, hitherto shut out from the community of living beings, received flesh and blood and demanded to be included with the existing fauna and flora in a single great genealogical tree, representing the history of life on our earth."

Darwin's book brought essentially two contributions. In the first place it brought a mass of *evidence* in proof of the proposition that animals are related to one another by descent. The *idea* of a process of evolution is very old and Osborn has recently traced its history from the early Greeks to the time of Darwin. Darwin did not originate the idea, he established it by a mass of evidence and it has been ever since accepted.

In the second place Darwin contributed the theory of the origin of species by natural selection. This theory is so well known that it need not be restated here, but it may perhaps be pointed out that the theory does not attempt to account for the origin of the variations upon which it depends. It is a fact that these variations occur and Darwin's theory bases itself upon this fact. He spoke of such variations as fortuitous. Aside from certain correlations, variations seemed to Darwin to occur by chance, though he did not exclude the possibility of their being later found to be subject to law.

The idea that the multitude of animal forms had thus originated by a process of evolution, and that this process was governed by a simple law, affected the whole subsequent course of zoology.

Zoologists soon came to accept not only evolution as a process, but natural selection as at least the chief explanation of the process. The zoologists following Darwin made but little attempt to study the variations upon which the theory of natural selection based itself, or to determine the range of variations or their causes. Having decided that animals were related to one another, and having fixed the law governing the origin of the relationship, zoologists began to turn their attention to a study of the degree of relationship. A mania seems to have become prevalent for the construction of a genealogical tree of the entire animal kingdom. The ultimate aim of zoologists ten years ago, or even five years ago was animal genealogy, and such is still the aim of many working zoologists. Paleontology, comparative anatomy and embryology were believed to furnish the means for unraveling animal genealogies.

All three of these lines of research have been pursued (from the phylogenetic standpoint) with great enthusiasm since 1859, and they are still being pursued; the results have, however, fallen far short of meeting anticipations. From the paleontological side it was evident from the first that many animals had left no recognizable fossil remains. In other cases the remains were so imperfect, so difficult of access and so few that nothing like a complete series could be hoped for. Paleontology has accomplished a great deal. Where it is available, it is without doubt the safest guide, perhaps the only safe guide in phylogenetic speculation. On the other hand it has not, and in the nature of its materials cannot lead to a realization of the zoologists' dream of a phylogenetic millenium.

Comparative anatomy has been to a considerable extent neglected during the past thirty years. Among the invertebrates, where the research could be carried on by the rapid methods of modern microscopic technique there has been more work, than among the larger vertebrates where it is necessary to use the tedious method of dissection. Among the anatomical research of the last quarter of a century there is a noticeable dearth of *monographic* work. In the earlier part of the century anatomists were not so much concerned with the discovery of relationships, they were content to work long on single animals, and there were thus produced anatomical monographs which have not since been surpassed in quality. With the advent of Darwinism came a feverish haste to detect relationships, and this resulted in a desire to compare large numbers of animals with one another. The time required to study the whole structure of a large series of animals was too great for the life time of one man. Much could, however, be accomplished by the comparison of a single organ through a large series of animals—and so the comparative anatomy of animals (monographic work) gave place to the comparative anatomy of organs.

A second characteristic of the comparative anatomy of this period has been its great reliance upon embryology. Its facts have been too often distorted to make them fit with the results of embryological work, and thus what should be the base of the pyramid has been made its apex.

Embryology was, however, the guiding star of the post-Darwinian workers. It seemed to offer by far the easiest and quickest solutions of their problems. It soon developed a technique of great intricacy and of great accuracy, and it came to offer easy conquests to the ambitious investigator. Its faintest hints at relationship were accepted as of the utmost importance and were given the deepest meaning. Scarcely any zoological work was complete without its embryological side. But it soon became evident that the development of an animal could not be construed as a simple repetition of its ancestral history. The ancestoral features were always more or less modified by features impressed upon the developing animal by its surroundings. The embryo was, so to speak, burdened by a double task. It not only repeated the history of its ancestor, but it had also to adapt itself to its own very different conditions. The development thus came to be considered as made up of two factors—those that were ancestral (phylogenetic) and those that were acquired by the embryo and peculiar to it (cænogenetic factors). The record was thus said to be falsified and to pick out the true from the false became the difficult task of the embryologist. This was a task requiring great judgment and one concerning which individual observers were likely to differ greatly. If an observer started out with a certain theory as to the ancestral history of an animal, all those factors in its development which did not accord with the theory, were apt to seem to him to be falsifications of the record. Another observer with the same facts before him, but working on a different theory, would discover that many of these so-called falsifications were really ancestral features.

Another factor which has hampered embryology as a phylogenetic discipline has been the too frequent limitation of the investigation to a single organ. It is easier to investigate a single organ through a series of embryos than to investigate the entire structure of all the members of the series. We are able to judge correctly of the character of a man only when we know all the elements that make it up. And so with a series of embryos, we must know the whole structure, not merely a part of it. Monographic work is here quite as necessary as in comparative anatomy.

Many illustrations might be given of the grotesque results reached in animal genealogy, principally through too great reliance on embryology. That investigators with the same facts before them may reach diametrically opposite conclusions is shown in the attempt to trace the ancestry of the vertebrates. No less than a dozen invertebrate groups have been announced from time to time as having furnished the vertebrate ancestor. The cœlenterates, the annelids, the nemertines, the crustacea, the spiders, Balanoglossus and the tunicates have all been candidates for this honor, and perhaps all deserve it equally.

With such results the zoological pendulum may be said to have reached, for the present, the limit of its excursion in the direction of phylogeny. It is now beginning to swing in another direction. Within the last five years, zoologists have begun to see that phylogenetic speculations have been to a large extent fruitless of specific results. They cannot be undertaken to advantage until we have vastly widened our field of knowledge. Then too it is being realized that the construction of a phylogeny of animals is, after all, not a matter of the greatest consequence. So long as we know that animals are related to one another and so long as we are able to investigate the laws which have governed the establishment of that relationship, it does not so much matter just *what* the precise relationship may be.

Zoologists are then turning in other directions. There seem to me to be chiefly four.

1. There is among those engaged in purely descriptive anatomy or embryology a tendency, not yet very pronounced, but yet growing, to return to the monographic method of working. This is a return to the methods of the beginning of the century and betokens a purpose to let speculation rest for a while, until more materials have accumulated upon which to base it.

2. There is a marked tendency to study *variations*. The first book on this subject has appeared within a few years, and has stimulated the production of many papers. The purpose of the workers in this field is to determine the nature and range of variation so as to gain a familiarity with the nature of the materials upon which natural selection acts. It may thus be possible, as Bateson points out, for the investigator of the future to say not 'if such and such a variation should occur,' but 'since such and such a variation does occur.' Students of variation hope also to discover some of the laws which determine the production of variations. It is believed that they are not, as Darwin thought, fortuitous, matters of chance, but that they are subject to well defined laws.

All phylogenetic speculation is based upon the idea of homology, but the study of variations has set our ideas of homology toppling and until these ideas are reconstructed we cannot hope for any final determination of animal relationships.

3. Toward a study of the effect of environment in inducing and modifying developmental processes. Experimental morphology, experimental zoology, experimental embryology, are new subdivisions of our subject which express this tendency. It is possible to subject developing animals to the influence of various factors of the environment in order to determine their effect. Developing eggs may be subjected to different temperatures, or to chemical solutions of different sorts and strengths or to the influence of electricity. In this way we may find what influence each of these factors has on development. Adult animals may be subject to similar changes of environment. The results of such researches are usually expressible by mathematical symbols, such as geometric curves or algebraic equations.

Such work is only in the beginning but it may ultimately lead to such an analysis of the environment as to enable us to assign to each of its factors its proper value as an element in organic development.

Experimental work is also being directed toward a determination of the internal factors of development, those which are resident in the animal itself and are not impressed upon it by the environment. The effect of the removal of portions of the developing egg, enables us to determine the part taken by those portions in the normal development of the whole egg. Others of the internal factors of development may be studied by direct observation (without experiment) and by comparison.

4. Toward a study of the activities of animals. Animals exhibit many sorts of activities that may be classified. Those connected with the taking of food, with reproduction, with the rearing of young, with construction of dwellings, with community life and so on. We are beginning to suspect that many of these activities have features that are common to large numbers of animals and that their origin and development may be traced with as much certainty as the origin and development of the organs of the animals. Many of the activities of man himself may doubtless be traced to an origin in the lower animals and much light thereby thrown on what we are pleased to call *human nature*.

Monographic work in its descriptive branches, the study of variation experimental work, and the study and comparison of the activities of animals seem then to be the directions in which zoological research is now turning.

The phylogenetic phase has passed the height of its development for the present and must await the accumulation of new data before it can again become dominant. But since the study of phylogeny does not really solve any philosophical question (but only gives form to a question already assumed to be solved) it is likely that it will never again become ascendant. Time will bring the solution of many of its problems, but such solutions are likely in the future to possess only a secondary interest.

On the other hand the new lines of work look toward the solution of the most important questions concerning the *method* of origin of organic forms.

Coincident with the gradual acceptance of the evolution idea, and coincident with the great development of morphological and phylogenetic ideas in our universities, there seems to have been a decline in popular activity in natural history. This did not become manifest immediately after 1859, but began, perhaps, ten or fifteen years after that date and has been in progress since then, up very nearly to the present time.

The most striking evidence of this decline is afforded by the decay of natural history societies. In this state Detroit and Grand Rapids each formerly supported such societies. They were well patronized, had rooms of their own, held stated meetings, and accumulated collections. The Detroit Society has long since decayed and its collections have passed into other hands. The people of Grand Rapids are so apathetic that there seems every reason to fear that they will permit the collections of the Kent County Society, to pass out of the city.

Many similar societies in other parts of the country have had like histories. A number of such are known to me.

This decline of popular interest has affected not so much the theories of natural history as its materials, not so much perhaps popular interest as popular participation. It has taken place by the side of an unprecedented activity in zoology in the universities and colleges and in the scientific work of the government.

May we not seek the explanation of it in two directions. First in the hostility or apathy of the church. So long as the study of natural history seemed merely to reveal the wonders of creation and to magnify the marvellous work of the creator, the church encouraged it. The evolution idea on the other hand was strongly combatted by the church. While it is, perhaps, not possible to trace the effect of this controversy on the popular interest in natural history, we may feel sure that a state of mind which looked upon every animal adaptation, as upon every visitation of disease, as an expression of divine wisdom, must have been more sympathetic toward the study of natural history, than one which saw in the animal only a vaguely comprehended end-result of an evolution process, itself subversive of accepted religious beliefs.

A further reason for the decline in popular interest may be sought in the lack of stimulus from above. The zoologists of the universities and colleges had become morphologists. A few of them kept up an interest in systematic zoology, but for the most part they were engaged in the laboratory study of the anatomy and development of preserved animals. Existing animals, the *end-results of an evolution process* were to be grouped in accordance with their genealogical history. The activities of animals, their habits, habitats, distribution, their relations to their environment, their ecology in short—all these were thought to be of little consequence. Students sent out from the laboratories of these teachers were much more familiar with sections and dissections than with living, or even entire animals. Once removed from the laboratory with its equipment of apparatus such students were quite helpless.

They experienced in most cases great difficulty in finding again in the field the animals that had served their laboratory studies. These students are the persons from among whom the membership in natural history societies is recruited. They are the persons who stimulate, in any community, an interest in natural history studies. These young recruits were then without interest in the study of living animals in their natural environment, while the people were, as they will likely always be, without interest in the laboratory study of anatomy and development. That which interests the people is not the dead end-product, but the living, active animal, the activities of animals, what they do and why they do it.

The people at large care but little about the structure even of man; they will know only what is necessary to care for the machine, and most of that they leave to the doctors. To know the origin of the various structures of man does not greatly interest them. How overwhelming on the other hand is their interest in man's *activities*. No other human interest transcends it.

But just as the structure of man has had a history: just as we may trace the development of his heart or brain through various stages which exist in the lower animals, so have the activities of man also had a history. The germs of his doings are to be found, perhaps all of them, among the lower animals. The social instinct, the home-building instinct, the instinct to care for the young, and how many others do we find in the lower animals. That these activities of the lower animals have given rise to those of man there seems little room to doubt. Just as the structure of man must be viewed against a background formed of the structures of lower animals, in order that it may be understood, so must man's activities be viewed against the background formed of the activities of lower animals.

Zoologists are only slowly coming to realize this fact, and in the study of variation and its causes, in the study of the relation between the animal and its environment, in the study of ecology, or experimental zoology, we see evidence of this realization.

In this movement, indeed, the popular interest and the popular wisdom find their justification. In so far as zoology affords an explanation of the origin of human activities, it becomes important in the conduct of life, in so far it justifies itself in the eyes of the people. Zoology is now passing rapidly out of the ultra morphological and ultra systematic phase, into a phase where it will concern itself more with the activities of living animals and with the relation of these to the environment.

In these matters it will again appeal to the popular interest. Students from our colleges and universities when they have quitted the laboratory will no longer feel themselves strangers to nature. When they go among the people they will stimulate the study of a rational natural history.

From this cause and from the final lapse of the now nearly extinct opposition of the church we may expect a popular revival of interest in natural history subjects. Indeed, the introduction of nature study into our schools, the increasing number of popular books and magazine articles on natural history indicate that this revival is already at hand.

In the days before Darwin natural history societies contributed no inconsiderable part to the advancement of the sciences of zoology and botany. This they did through their collections and through the discovery by their members of new species, new localities and hitherto unknown habits of animals. May not the revival of popular interest which seems to be at hand again contribute to the advance of zoology? Observations on the daily life of animals, on their distribution and variations, on related subjects, may be made without the elaborate equipment of laboratory and library that is necessary for morphological work. Such observations are well possible to isolated members of a society like this one, and carefully made and well thought out, become real contributions to our science.

Jacob Reighard.
University of Michigan.

THE STEAM-TURBINE.

An apparently important, and to the writer, at least, new, fact in the operation of the steam-turbine is revealed by experimental investigations in progress for some time past in the laboratories of Sibley College, with both saturated and superheated steam. Contrary to the usual theory of that apparatus, it is found that a very substantial gain may be had by the use of superheat, not only in efficiency but also in *capacity*.

The steam-turbine is not subject to that form of waste known as 'initial' or 'cylinder' condensation which adheres to every piston-engine as a consequence of the large fluctuations of temperature which accompany the variations within the cylinder between boiler and condenser pressures, and which, with the best of engines employing saturated steam, amount to ten or twenty per cent. and to a multiple of such figures for small machines. The interior surfaces of the turbine, in steady working, remain at precisely the same temperatures and absolutely without those fluctuations which produce waste in the reciprocating, and in the other forms of rotary, engine. As it is to reduce this particular waste that superheating is employed, ordinarily, there would not be expected to be found any other gain by its use in the steam-turbine than that increase of thermodynamic efficiency which is due to the widened range of temperature, in this case amounting to about one-tenth of one per cent. per degree of superheat. Investigations by Messrs. Schieren and Thomas, above alluded to, show, on the contrary, a gain of about one per cent. for each one and two-thirds degrees, C., three Fahrenheit degrees, of superheat and the remarkable and unexpected result of an increase in the capacity of the machine of about one hundred per cent. by the use of but 20° C., 37° Fahr., superheat. The 'water-rate' of the turbine, a La Val machine of ten horsepower as rated, decreased from about 21.7 kgs., 48 lbs., to 1.99 kgs., 44 lbs, with pressure rising from three atmospheres to eight, with a two-thirds vacuum, and with saturated steam; while the figures fell off about 12 per cent. with superheating, rising to a very moderate maximum as above. Reduced to thermal units per horse-power per hour, the same effect appears in a very similar proportion. The causes of the gain in thermodynamic efficiency and of capacity are presumably identical—the extinction of the friction-wastes due to the retardation of the current of fluid traversing the passages of the turbine by concurrent resistances coming of the weighting of the current of steam with drops and mist and the adherence of moisture in mist, drops and even streams, very probably, to the walls of the steam-passages of the turbine. The phenomenon will however, be the subject of extended investigation in the course of the work in research constantly in progress and a way will probably be found of precisely identifying the cause and determining the laws governing its action in the production of these variations of efficiency and capacity. That this apparently obvious explanation is the correct one and, certainly, that the gain is not due any such action as produces the remarkably beneficial effects observed in the reciprocating engine, is tolerably well indicated by the fact that the gain in this case, by superheating, is substantially proportional, so far as here carried, to the amount of superheat and the graphic log shows a straight line of decreasing consumption of steam.

R. H. THURSTON.

THE MORINGUOID EELS IN AMERICAN WATERS.

NOTWITHSTANDING the numerous eels which have been discovered in American waters, none has yet been found which has been referred to the family of *Moringuidæ*. Indeed, from the literature it would appear that the group was peculiar to the seas of India and the Molucca-Indian archipelago. However, Dr. Smith recently received from Mr. George M. Gray, of Woods Hole, an eel found in branching coral at San Geronimo, near San Juan, on the north shore of the island of Porto Rico, which he was at a loss to allocate and took it to Dr. Gill. The latter was struck by its resemblance to *Aphthalmichthys*, and the subsequent comparison with the figures of Bleeker's 'Atlas Ichthyologiques des Indes Orientales Néêrlandaises' revealed no differential characters to separate it from that genus. Further, a consideration of the very elongated whiplike forms referred by Jordan and Evermann to the subfamily *Stilbiscinæ* of the family *Murænesocidæ* shows that all are true *Moringuidæ*, the genus *Stilbiscus* being identical with *Moringua*, having the same structure of the fins. Instead of American waters being destitute of representatives of the family, it now turns out that they are the headquarters of the group and that four genera are found therein—*Moringua, Aphthalmichthys, Leptoconger* and *Gordiichthys.*

The Porto Rican *Apthalmichthys* agrees most closely with the *A. abbreviatus* of the Indo-Moluccan archipelago (Java, Celebes, Amboyna, etc.). It has a more elongated body (the depth about 54 times in the length), and the head forms one-thirteenth of the length. No true pectorals are developed, although a slight fold exists behind the upper portion of the branchial aperture. The tail forms a little more than one-third of the length. The color in life was a uniform gray olive. The specimen is 270 mm. long. The species may be called *Aphthalmichthys caribbeus.* A detailed description will be published hereafter.

This discovery is of unusual interest. It takes a family out of the category of geographically restricted types and adds one to those of tropicopolitan distribution. It is probable that species will be found under analogous conditions in all tropical seas and that they are rare only in museums. But they are of such a shape and occur amidst such environments that they can only be secured by some happy accident, unless they may be deliberately sought for with proper appliances. The family itself has special interest for the morphologist. The species differ from all others in the great extent of the abdominal cavity (about two-thirds of the total length) and the situation of the heart, which is far behind the gill arches and not close to the hindmost one as in fishes generally.

Theo. Gill.
H. M. Smith.

A PRELIMINARY ACCOUNT OF THE SOLAR ECLIPSE OF MAY 28, 1900, AS OBSERVED BY THE SMITHSONIAN EXPEDITION.

Partly in deference to the report of the United States Weather Bureau, from which it appeared that the chance of a fair eastern sky on the morning of the eclipse was about 8 to 1, and after examination by Mr. Abbot of many stations in North Carolina, Wadesboro, of that State, was selected early in April as the site of the Smithsonian observations. The advantages of Wadesboro being also recognized by Professor Young, of Princeton, Professor Hale, of Yerkes Observatory, and the Reverend J. M. Bacon, of the British Astronomical Association, it came about that four large observing parties, besides several smaller ones and numerous excursionists from the surrounding country, were all joined to produce at Wadesboro one of the largest company of eclipse observers ever assembled for scientific purposes. It is a matter for congratulation that the sky at Wadesboro upon the day of the eclipse was cloudless and clearer than the average, so that the efforts of the observing forces were not thwarted by any circumstances beyond their control. The provisions of the Mayor and authorities of Wadesboro for preventing intrusion before and during the eclipse, and thus securing an undisturbed field of operations, deserve especial recognition. Further than this, the many acts of courtesy and hospitality to the visiting astronomers on the part of the townspeople, will long be remembered by the recipients.

The Smithsonian party proper consisted of thirteen observers, and included Mr. Langley, Mr. Abbot, Aid Acting in Charge of the Smithsonian Astrophysical Observatory, Mr. Smillie, in charge of photography, Mr. Putnam, of the United States Coast Survey, Mr. Fowle, Mr. Mendenhall, Mr. Child, Mr. Draper, Mr. Gill, Mr. Kramer and Mr. Smith. Included with these the

Reverend Father Searle and the Reverend Father Woodman gave most valuable assistance. Mr. Hoxie, of Port Royal, South Carolina, and Mr. Little, of Wadesboro, rendered valued assistance to Mr. Putnam during totality.

Professor Hale, of the Yerkes Observatory, was a member of the party, while still in general charge of the Yerkes expedition, and his counsel and aid were of the greatest service. Mr. Clayton, of Blue Hill Meteorological Station, occupied a part of the grounds of the Smithsonian party.

The main object of the investigation was of course the corona, and of this (first) a photographic and visual study of its structure, with (second) a determination by the bolometer whether appreciable heat reaches us from it, and, if possible, an examination of the form of its spectrum energy curve.

The writer had been particularly struck, when observing the eclipse of 1878, on Pike's Peak, by the remarkable definiteness of filamentary structure close to the sun's limb, and had never found in any photographs, not even in the excellent ones of Campbell taken at the Indian eclipse of 1898, anything approaching what he saw in the few seconds which he was able to devote to visual observations at the height of 14,000 feet. His wish to examine this inner coronal region with a more powerful photographic telescope than any heretofore used upon it, was gratified by the most valued loan, by Professor E. C. Pickering, of the new 12-inch achromatic lens of 135 feet focus just obtained for the Harvard College Observatory. This lens, furnishing a focal image of more than 15-in. diameter, was mounted so as to give a horizontal beam from a coelostat clock-driven mirror by Brashear, of 18-inch aperture, and used with 30-inch square plates. To supplement this great instrument, a 5-inch lens of 38-ft. focus, loaned by Professor Young, was pointed directly at the sun. This formed images upon 11x14 plates moved in the focus of the lens by a water clock. Specially equatorially mounted lenses of 6-, 4- and 3-inch aperture, driven by clock work, were provided for the study of the outer corona, and the search for possible intra-mercurial planets.

For the bolometric work the massive siderostat, with its 17-inch mirror, with a large part of the delicate adjuncts employed at the Smithsonian Institution in recent years, to investigate the sun's spectrum, was transported to Wadesboro. The excessively sensitive galvanometer reached camp without injury even to its suspending fiber, a thread of quartz crystal $\frac{1}{15000}$ inch in diameter.

Besides these two chief aims (the photography and bolometry of the inner corona), several other pieces of work were undertaken, including the automatic reproduction of the 'flash spectrum' by means of an objective prism with the 135-ft. lens; the photographic study of the outer coronal region, including provision for recognizing possible intra-mercurial planets, already alluded to, visual and photographic observations of times of contact, and sketches of the corona both from telescopic and naked eye observations.

The assignment of the observers was as follows: Mr. Langley, in general charge of the expedition, observed with the same 5-inch telescope used by him on Pike's Peak in 1878, which was most kindly lent for this special comparison by Professor Brown of the U. S. Naval Observatory; C. G. Abbot, aid acting in immediate charge, assigned with C. E. Mendenhall to the bolometer; T. W. Smillie, having general direction of the photographic work, made exposures at the 135-ft. telescope; F. E. Fowle, Jr., assigned to 38-ft. telescope; Father Searle, directing the assembled telescopes for the outer coronal region, and for intra-mercurial planets, assisted by P. A.

Draper and C. W. B. Smith, exposed two cameras of 3-inch aperture and 11-ft. focus, and two of 4½-inch aperture and 3½-ft. focus; all four of these telescopes being mounted on a single polar axis driven by an excellent clock; DeLancey Gill assisting Mr. Smillie, removed the flash spectrum objective prism at second contact, and made a single long exposure with a 6-inch photographic lens of 7½-ft. focus equatorially mounted; Assistant G. R. Putman, who by the kindness of the Superintendent of the U. S. Coast Survey, was detailed for latitude,* longitude,† and time observations, also observed contacts, directed the striking of signals by Mr. Little, and rendered other valuable services. Mr. Putman was assisted in recording contacts by Mr. Hoxie. R. C. Child, observing with a 6-inch telescope of 7½-ft. focus, made sketches with special references to inner coronal detail, and was in addition charged with all electrical circuits for chronograph and automatic photographic apparatus. Father Woodman, with 3½-inch telescope, observed contacts and made sketches.

The first detachment, consisting of Messrs. Abbot, Fowle, Kramer (instrument maker) and Smith (carpenter), reached Wadesboro May 4th, and were soon joined by Messrs. Draper and Putnam. The latter returned to Washington after a short but satisfactory latitude and longitude campaign, reaching Wadesboro again just before the eclipse. Other members of the party reached camp on and after the middle of the month. The first comers found a very satisfactory shed already erected and piers begun. Not a day passed from the time of the arrival of the apparatus, May 7th, to the day before the eclipse, that was not fully occupied in perfecting the arrangements.

The most striking portion of the installation was the line beginning at the northwest pier, with its equatorial and cœlostat, continued from thence south of east by the two great diverging tubes of the 135-ft. telescope and spectroscope. These tubes were covered with white canvas, presenting the appearance of two immensely prolonged 'A' tents, ending beyond the photographic house, where the 38-ft. telescope tube pointed east and upward at an angle of 42° with the horizon. When the equatorial, with its large special conical tube camera, with all this long branching extent of white canvas ending in the uplifted tube of the 38-ft. telescope, was seen in the light of the moon, the extensive field with its preparations exhibited a still more picturesque scene than by day.

Less imposing, and perhaps more ungainly, was the combination of four great cameras under the main shed, designed to search for new planets and to depict the outer corona. These might well be described as like a cabin and an outbuilding, mounted on a polar axis, yet despite their awkward proportions they were made to follow very accurately.

The morning of the eclipse dawned cloudless and very fairly clear. Deep blue sky, such as the writer had seen on Pike's Peak, of course is not among the ordinary possibilities of an eclipse, but the milkiness of the blue was less pronounced than is usual in the summer season, and all felt that the seeing promised well.

At fifteen minutes before totality a series of rapid strokes on the bell called everyone to his post, and one minute before the expected contact five strokes were given as a final warning. Coincidentally with the actual observation of the second contact by Mr. Putnam, the first of two strokes upon the bell sounded, and the work began. After 82 seconds (the duration of totality from the Nautical Almanac was 92 seconds) three strokes were given as a signal to stop the long photographic exposures. Scarcely

* 34° 57′ 52″ N.

† 5^h 20^m $17^s.8$ W.

more than five seconds after this the sun's crescent reappeared. The duration of totality as observed by Mr. Putnam was approximately 88 seconds.

To visual observers the sky was notably not a dark one. No second magnitude stars were observed with the naked eye, and most of the on-lookers saw only Mercury conspicuously, though Venus was distinguished at a low altitude, and Capella also was seen. So high a degree of sky illumination cannot but have operated unfavorably in the study of the outer corona or in the search for intra-mercurial planets, and this is to be remembered in connection with what follows.

BEFORE TOTALITY.

A deepened color in the sky, a fall of temperature and a rising breeze were distinctly noticeable. No change in direction of the wind was noticed. Shadow bands were seen, but those who attempted to measure their velocity found them too rapid and flickering for any great exactness in this determination. There was tolerable unanimity among independent observers as to their size and distance apart (about 5 inches) though some thought this less, as totality approached.

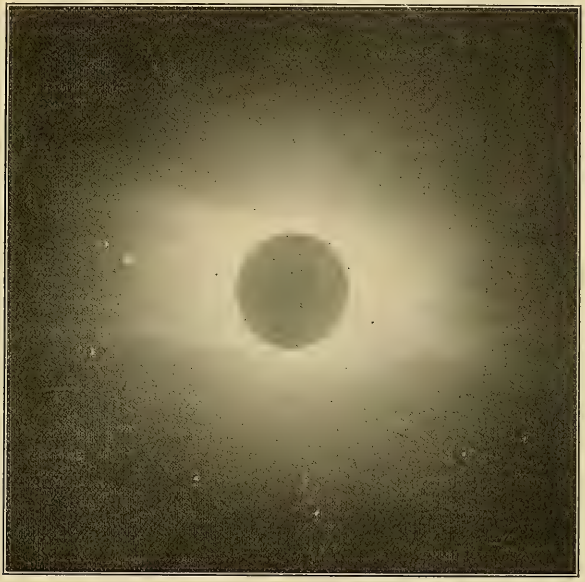

FIG. 1. General view of the corona. Taken with 6-inch lens of $7\frac{1}{2}$ feet focus. 82 seconds exposure.

It was noticed that the birds grew silent just before and during totality, but true to their nature, the English sparrows were last to be still and first to begin their discussion of the eclipse, after the return of light.

DURING TOTALITY.

The attention of all visual observers was at once caught by the equatorial streamers.

Father Woodman's comparison of the appearance to a structure of mother of pearl was generally recognized as good, but different observers differed on the color estimate. A yellowish green tinge was noticed by the artist of the party, Mr. Child, while to others the light was straw-colored or golden.

The general coronal form, to the naked eye, was nearly that of the small annexed photograph, which, though taken by one of the smaller objectives, gives a good view of the relative intensities. The same extensions of the equatorial corona could be followed by the naked eye from 3 to 3½ solar diameters.

The visual telescopic observations of the writer gave little indication of the finely divided structure of the inner corona which he had noticed at Pike's Peak. Structure, to be sure, was evident, but not in such minute subdivision as had then been seen, and though one remarkable prominence as well as several smaller ones was visible, the coronal streamers did not give to the writer the impression of being connected with these prominences, though the relationship of some of them to the solar poles was abundantly manifest.

AFTER TOTALITY.—RESULTS.

Comparing notes after totality, all observers reported a successful carrying out of the program. The greatest interest centers in the direct coronal negatives taken with the 135-ft. telescope. Mr. Smillie exposed six 30x30 plates during totality, with times ranging from ½ a second to 16 seconds, and three others were exposed by him immediately after the third contact.

At this writing, only a part of the negatives taken have been developed. Their general quality may be inferred from the examples here given, after due allowance for the great loss suffered by translation on to paper even with the best care.

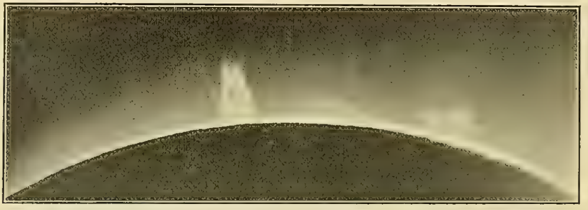

Fig. 2. Prominences on southwest limb of sun. Taken with 12-inch lens of 135 feet focus. Exposure 8 seconds.

Figure 1 is a view taken with one of the smaller objectives (6 inches), given here to afford the reader an idea of the general disposition of the coronal light. The upper part is the vertex in the inverted field.

Figure 2 is a portion of one of the great 15-inch circular images obtained with the 135-ft. focus telescope. It was obtained in the great disk in the last exposure during totality of 8 seconds, showing one of the principal prominences then on the sun's disk, with a disposition of the lower filaments near it.

Fig. 3 is a portion of the same set of plates, but taken with a 16 second exposure. The part near the sun has, of course, been intentionally over-exposed, in order to better exhibit the remarkable polar streamers, extending here to a distance of about six minutes from the sun, but still further in Mr. Child's telescopic drawing (not given).

Figure 4 is a view of a small part of the great apparatus on the field, including the terminus of the horizontal tube with its canvas covering, which has been described as like an extended 'A' tent. The photographic room is seen at the end of the tube and beyond that the tube containing the lens loaned by Professor Young, pointing directly skyward.

That it will be impracticable to give here all of the disc of the moon in the large photographs, will be evident when it is considered that the lunar circumference on each plate is about 4 feet; but it will be inferred from the examples that the prominences and polar streamers as well as their features, appear in imposing magnitude and detail.

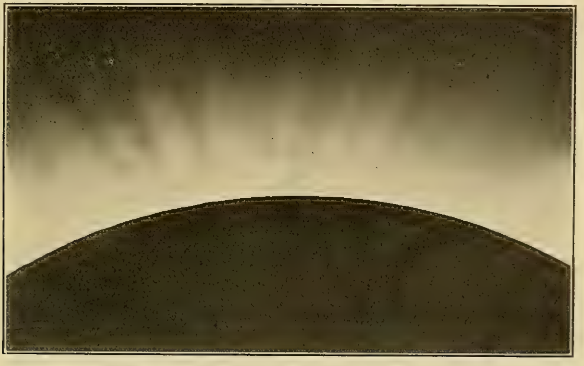

FIG. 3. North polar coronal streamers. Taken with 15-inch lens of 135 feet focus. Exposure 16 seconds.

Many of what it is hoped will be most interesting photographs still await development, but Mr. Smillie's thorough preparation is promising adequate results.

HEAT OF CORONA.

Mr. Abbot, with the aid of Mr. Mendenhall, appears to have measured the heat of the corona, and in spite of previous efforts, this is probably the first time that it has been really shown to exist. For five minutes before second contact, the bolometer was successfully exposed to the region of the sky close to the narrowing crescent of the sun where the corona was shortly to appear. A diaphragm was interposed in the beam having an aperture of only 0.4 sq. cm. and deflections rapidly diminishing from 80 to 6 mm. were obtained, the last being about 40 seconds before totality. Then the diaphragm was opened to 290 sq. cm. and a negative deflection of 13 mm. was observed after totality, where these positive deflections had just been found, showing that the corona was actually cooler than the background which had been used at the room temperature. Next the black surface of the moon was allowed to radiate upon the bolometer, and the still larger negative deflection of 18 mm. was observed.

The important result was that the corona gave a positive indication of heat as compared with the moon.

This heat, though certain, was, however, too slight to be subdivided by the dispersion of the prism, with the means at hand.

The negatives taken to depict the outer

corona show from three to four solar diameters extension for the longest streamers. The equatorial 'wings' as they recede from the sun, are finally lost in an illuminated sky, without any indication of having actually come to an end.

No attempt to carefully examine the plates taken for intra-mercurial planets has yet been possible. It is, however, as has been remarked, doubtful if very faint objects will be found, in consideration of the considerable sky illumination during totality. However, Pleione in the Pleiades, (a star of the 6.3 magnitude) is plainly seen on one of the plates and some smaller ones are discernible.

On the whole, the expedition may be considered as promising to be very satisfactory in its results, and that it was so, is largely owing not only to the efficient care of Mr. Abbot, but to the many gentlemen who have assisted me with the loan of valuable apparatus, with counsel, with voluntary service, and with painstaking observation, to one and all of whom I desire to express my obligations.

S. P. Langley.

Smithsonian Institution,
Washington, D. C., June 9, 1900.

Fig. 4. Dark room and tubes of 135 foot and 38-foot telescopes. 5-inch equatorial in foreground, Professor Langley observing.

SCIENTIFIC BOOKS.

Text-Book of Paleontology. By Karl A. von Zittel. Translated and edited by Charles R. Eastman. English edition, revised and enlarged by the Author and Editor, in collaboration with C. E. Beecher, J. M. Clarke, W. H. Dall, G. J. Hinde, A. Hyatt, J. S. Kingsley, H. A. Pilsbry, C. Schuchert, S. H. Scudder, W. P. Sladen, E. O. Ulrich, C. Wachsmuth. London and New York, Macmillan & Co. 1900. Vol. I. 8vo. Pp. x + 706. 1476 woodcuts.

This volume is the result of an interesting experiment. To take an epitome of a science, impressed with the individuality of an eminent investigator, who is if anything even more eminent as a teacher, a clear synopsis drawn up on an harmonious plan, distinguished by both breadth of outlook and a restraining common sense, and then to entrust the several chapters of this work to men who are essentially specialists and enthusiasts, many of them without notable experience as teachers, and to permit them to correct, revise, or even rewrite as each thinks fit: the very boldness of the attempt deserves success. But when the original author is representative of the somewhat conservative European school of thought, and his revisers are for the most part leading exponents of revolutionary American ideas, then who can wonder if the result is curious rather than satisfactory? Professor von Zittel would be the last person to claim infallibility, and it is not surprising that the enormous mass of detail condensed into his 'Grundzüge der Palæontologie' should contain some removable errors. Dr. Eastman might with advantage have done one of two things. He might have given us a translation of the 'Grundzüge' with these errors corrected by his corps of specialists; or he might have sketched out the plan of a new work, in which the phylogenetic and morphogenetic principles of Professors Hyatt, Beecher and others should have had free play. But what we have here is neither one thing nor the other. The mistakes of the original are in very many cases still uncorrected, often added to in somewhat inexplicable fashion (as when Wachsmuth alters the correct '*Holocrinus* W. u. Spr.' to the incorrect '*Holocrinus*, Jaekel'); on the other hand, the opinions of the Munich professors, which after all are entitled to some respect, have as often as not been brushed aside, and some new and untried scheme of classification put in their place. The unity of the work, as the author's own preface points out, has been destroyed, and the student is presented on the supposed authority of Zittel with views opposed not merely to those of that eminent paleontologist, but often to one another. The climax is reached when most of the genera referred on pp. 102 et sq., to the Chætetidæ and Fistuliporidæ, families of Anthozoa, are repeated under Bryozoa as Cerioporidæ (p. 266), Fistuliporidæ (p. 269), Monticuliporidæ (p. 272), Heterotrypidæ (p. 373), Calloporidæ (p. 274), and Batostomellidæ (p. 277). We are left wondering what is to become of *Chætetes* (which no doubt is a coral) and *Labechia* (which is probably a Stromatoporoid). In this way the elementary student is fogged, while the more advanced student is uncertain on whose authority doubtful or novel statements are made. And possibly some may think that the advertisement of this book as a 'Text-book of Paleontology by Karl A. von Zittel' is an unwarrantable use of a famous name and an abuse of the professor's well-known kindness.

After this protest it is pleasant to be able to express gratitude for much of the fare with which the enterprise of Dr. Eastman and Messrs. Macmillan has provided us; and more particularly are thanks due to the many specialists who have undertaken a difficult and ungrateful task.

English speaking readers should be glad to have Professor von Zittel's admirable Introduction in more accessible form. The translation is flowing without being much too free; but the statement (on p. 8) that "many fossil crinoids before maturity resemble the living genus *Antedon*" is not the same as "many fossil crinoids may be compared with the young stages of the living genus *Antedon*." To say that the application of the term 'fossil' to any organic remains is determined solely by 'the geological age of the formation in which they occur,' is unnecessarily to exaggerate a restriction which Professor von Zittel has already made too strong. An explorer in a new country finds a cliff containing shells or bones; these eventually prove to be of identical species with animals now living in the neighborhood, and it is inferred that the rock has been formed and elevated within the historic period. The observation is a geological observation, and the argument is precisely the same as it would have been had the organisms proved of Cretaceous age. Why should the remains be called fossils in one case and not in the other? The true criterion seems to be that 'fossils' have been buried by natural causes. Thus one emphasizes that uniformity of geological operations which Professor Zittel's qualification tends to obscure.

The chronological table would have been of more service to those for whom the translation is intended, had the gallicised terms of the last column been replaced, so far as possible, by American equivalents. It is hard to see the point of 'Danian Series (Danien), Senonian Series (Senonien)' and so on.

The chapters on Protozoa and Cœlenterata, the latter including Sponges, show little alteration, which is just as well. Additional references to writings on Protozoa are given on p. 36, but among them is no mention of C. D. Sherborn's 'Bibliography of the Foraminifera.' On p. 82, Professor von Zittel has himself added a summary of Dr. Ogilvie-Gordon's classification of Anthozoa, but without expressing any opinion as to its value.

The account of the Crinoidea, good as it was in the 'Grundzüge,' has been greatly improved, presumably by Wachsmuth, who also made valuable additions giving the latest views of Wachsmuth and Springer. This should be most useful to those unable to see the splendid monograph by those authors. The same learned writer also revised the accounts of the Cystoidea and Blastoidea. It is the more unfortunate that so authoritative a piece of work should be marred by several slips. Fig. 237, *A*, *a* is not a 'posterior view' of *Pisocrinus*, but is from the right side, as also is *B*, *a*. The stem of *Herpetocrinus* is anything but 'sharply pentagonal' in section (p. 153). *Achradocrinus* appears in two families (pp. 155, 158); the former position, in the Gasterocomidæ, is probably the correct one. The calyx of Apiocrinidæ is not 'unsymmetrical' (p. 167). 'Jaekel regards the centrodorsal (of *Tetracrinus*) as representing the anchylosed basals, notwithstanding the absence of axial canals,' should read: 'because of the presence of axial canals.' Fig. 296, '*Caryocrinus*' should be *Caryocystis*. *Camarocrinus Lobolithus* and *Lichenocrinus* are without doubt the roots of Pelmatozoa and not cystid calyces, as on p. 183. The anus of *Anomalocystis* is unknown; the account of it on p. 186 is therefore incorrect. The analysis of a Blastoid theca (Fig. 312) is oriented in a very puzzling manner; the uppermost radial is the right anterior, the lowest deltoid is the left posterior, the lower deltoid on the right is therefore the posterior and ought to show a notch or hole for the anus. These little slips are just the things that worry an earnest student.

Mr. W. P. Sladen has not taken advantage of the opportunities offered by a revision of the Asteroidea and Ophiuroidea, while in the Echinoidea he has not advanced beyond the classification of Duncan in his Linnean Society paper with its pre-Linnean nomenclature. The account of the sea-urchins is, however, clear and comprehensive, and additional references to publications are given. Among these the reference to Keyes, *Proc. Iowa Acad. Sci.*, Vol. II., will not be of much use to students on this side of the water, if I may judge by my own fruitless attemps to see that paper.

A little more exactitude has been introduced by Dr. G. J. Hinde into the chapter on those troublesome fossils assigned to worms of one sort or another. One looks in vain, however, for any pronouncement on the perplexing *Platysolenites* of the Cambrian. Its associate, *Volborthella*, is placed among the Cephalopoda, a position that will need some defending.

The account of the Bryozoa has been expanded from 9 to 34 pages by Mr. E. O. Ulrich, and many illustrations have been added. This careful piece of revision is most welcome.

Recent work on the Brachiopoda is summarized by Mr. C. Schuchert, who has contrived to classify all the genera on the basis given by Beecher. Modification in details will doubtless be required, but Mr. Schuchert works on advanced lines, and his attempt must prove of the greatest service to the many workers who are attempting to apply modern ideas to the vast hordes of fossil brachiopods.

In entrusting the Pelecypoda to Dr. W. H. Dall and the rest of the Mollusca, with exception of the Cephalopodes to Mr. H. A. Pilsbry, Dr. Eastman has been well advised. There are no higher authorities on those groups. Dr. Dall's contribution is an adaptation of his memoir published by the Wagner Free Institute of Philadelphia in 1895. The main divisions, based largely on the characters of the hinge, may commend themselves to those who deal mainly with the fossil shells, while Dr. Dall has evaded the objections that have been raised to some of the minor groupings—Palæoconcha, Schizodonta and the like—by stating that these terms are retained 'merely as convenient descriptive appellations, and are in nowise to be regarded as possessing systematic values.' Though further investigation both of adult morphology and of ontogeny is sure to modify the phylogenetic bases on which the ultimate classification must rest, yet this careful synopsis will prove of distinct value for reference. Neither Dr. Dall nor Mr. Pilsbry departs so far from accepted ideas that his scheme cannot easily be used by those accustomed to the views of other teachers. In this connection, however, one point may puzzle the inquirer, and that is the attachment of the names of the present writers to family names that were well known almost before those gentlemen were born. What for instance is the meaning of 'Chitonidæ, Pilsbry'; 'Arcidæ, Dall,' or 'Anatinidæ, Dall'? It must be recognized by this time that scarcely any family is regarded by each fresh systematist in the precise sense of the first founder; and if Lamarck, Gray and the rest are quoted in some cases, why not in others? No attempt to attribute authority to family names can attain absolute justice, and the simplest solution is to omit the names of authorities altogether. But if Mr. Pilsbry, for example, claims to have modified the conception of Chitonidæ, it would be well to give the date of the publication in which it was done, so that we may know precisely what value to attach to the collocation 'Chitonidæ, Pilsbry.' Fortunately there do not appear to be any new generic names in these chapters: *Prolucina*, Dall, is unfamiliar certainly, but had it really been new, so careful a worker as Dr. Dall would have indicated the fact.

It is deeply to be regretted that the above commendatory remarks cannot be extended to the section on Tetrabranchiate Cephalopoda. Professor Hyatt has devoted his high abilities to the study of those animals with such enthusiasm and success, that his account was eagerly expected. It is a disappointment. What we are given is little better than a preliminary notice of 'an exhaustive monograph,' which will doubtless have great value when it appears; but the present abstract is of slight use to the beginner and incomprehensible even to the specialist. One can sympathize with a man of peculiar knowledge and original ideas, called upon suddenly to edit an account with which he is in total disagreement; but Professor Hyatt has attempted too much for the allotted space. Dr. Eastman, as editor, should have refused these crowds of new and undefined genera, thus making room for clearer elucidation of the principles on which the new classification was erected. He should also have eliminated the numerous inconsistencies that disfigure the work. They are of many kinds: family names sometimes have an author's name added, sometimes not; a species is often ascribed to two different authors, there are three instances on pp. 588–9; the legends to figures do not always agree with the text; the genders of adjectives do not always agree with their substantives; there is also a confusion, which might easily have been avoided, between the 'siphon (funnel)' and 'siphuncle' of Professor Verrill, and the 'siphonal funnels,' 'siphuncle' and 'siphon' of Professor Hyatt. The retention of Tetrabranchiata as a subclass to include both Nautiloidea and Ammonoidea is perhaps not due to Professor Hyatt; it involves certain statements concerning extinct forms, and especially concerning Ammonoidea, that are absolutely unwarranted by evidence.

It is not clear who is responsible for the changes in the account of the Dibranchiate Cephalopods. But it is clear that the homologies of the cuttle-bone are not yet appreciated. When they are, we shall no longer see *Belemnosis*, *Beloptera* and *Spirula*, in one suborder, and *Belosepia* and *Sepia* in another.

The recasting of the section on Trilobites by Professor Beecher, and that on Merostomata by Dr. J. M. Clarke, the latter incorporating the results of Holm, Laurie and others, will prove most useful. There are also other changes of value under the head Crustacea, due to Professor J. S. Kingsley, Dr. J. M. Clarke and Mr. E. O. Ulrich. But while we would gladly leave the precise classificatory relationships of Trilobita and Merostomata still unsettled, we should like to see the discovery of *Pollicipes* and *Scalpellum* in the Silurian of Gotland recognized by some text-book before another eight years have passed.

The defects in form and arrangement shown by this volume must be a source of regret to all who believe that a good book covering the whole field of systematic zoology cannot nowadays be written without the co-operation of specialists. To attain success, an editor is required honey-tongued enough to get all he wants out of his helpers, strong enough to subordinate them to the scheme of the book, and with grasp enough to weld their contributions into a consistent whole. With the experience he has now acquired, and with his own relatively greater knowledge of the subject, Dr. Eastman will doubtless do better in Volume II. Meanwhile this first volume forms a wonderful storehouse of facts, drawings and names ; and no more reliable compendium of the paleontology of invertebrate animals is to be obtained.

The copy submitted for review bears date 1900, and there is no indication of the fact that pages 1–352 were first published in November, 1896. They were issued in a separate wrapper, with title marked Vol. I., Part I., and dated London and New York, 1896. But as it happens, this Part I. was *not* published in London : the publishers refused, and still refuse, to sell it in England, and I owe my copy to the kindness of Dr. Eastman. Therefore both title pages are bibliographically incorrect—'for trade reasons.' I am also informed that the sections by Dr. Dall and Professor Hyatt were distributed some time ago ; but that was no doubt a private matter, which cannot affect the date of the new names.

Trade reasons must also account for the fact that the English editions of so many German scientific works are printed with a smaller page, into which the illustrations do not fit. But it is to be hoped that there is no real need for such works to be printed on porous paper. This is particularly unfortunate in the case of really useful books, such as the present, deserving of permanent correction and annotation.

F. A. Bather.

The Meyer's Kinetic Theory of Gases. Oskar Emil Meyer, translated from the second revised edition by Robert E. Baynes. London, New York and Bombay, Longmans, Green & Co. 1899. Pp. xvi + 472.

"I undertook therefore to exhibit the kinetic theory of gases in such a way as to be more easily intelligible to wider circles, and especially to chemists and other natural philosophers to whom mathematics are not congenial. To this end I endeavored, much more than was otherwise usual, not only to develop the theory by calculation, but rather to support it by observation, and found it on experiment."

This extract from the Author's Preface, apparently written in English by the author, will be recognized by all who know his treatise in any form, old or new, as an accurate description of his work. Boltzmann, in the *Vorwort* to his *Gastheorie*, remarks: "Jedoch verfolgt das Meyer'sche Buch, so anerkannt vortrefflich es für Chemiker und Studirende der Physikalischen Chemie ist, völlig andere Zwecke." The contrast between the purpose of Meyer and that of Boltzmann is as marked now as it ever was; for the new edition of Meyer follows very closely the lines of the first. The nut is still cracked for us in the first part of the book and the kernel exposed, while the shell is carefully saved in the mathematical appendices for those who may be disposed to try their teeth upon it.

The clear yet compendious character of the treatise has made it an excellent book to consult; and it has therefore seemed to the reviewer worth while to make a somewhat detailed comparison of the new English edition with the old German one, in order to note the developments which have been made during the past twenty-three years in what may be called the physicist's, as distinguished from the mathematician's, knowledge of gases. The following quotations are accordingly selected to illustrate the most important of these changes. They touch many, but not all, interesting features of the kinetic theory. It will be seen that the time since the first edition of Meyer appeared, in 1887, has been for this theory a period of confirmation and careful improvement rather than one of revolution or rapid advance. The nature and results of intermolecular attraction, the conformation and internal properties of the molecule, these are the problems with which the theory is now engaged, and these are problems with which progress may well be slow.

In the following reviews the title of each successive chapter, up to the mathematical appendices, will be given, even when the chapter contains nothing deserving of special mention as new.

Chapter I.—*Foundations of the Hypothesis.*

Chapter II.—*Pressure of Gases.*

Chapter III.—*Maxwell's Law of the Unequal Distribution of Molecular Speed.*

"Its discoverer, J. Cl. Maxwell, first proved it by the assumption of a principle which, though true, itself needs proof. Since Maxwell himself recognized this defect, he later gave a second proof, the basis of which is subject to no doubt" (p. 45). "L. Boltzmann completed and perfected this proof by employing stricter mathematical work, and thus removing just ground for doubt. A further step forward [1887] we owe to H. A. Lorentz, who raised a new objection and improved the calculation, thereby inciting Boltzmann to again give a new proof [1887], which proof may now be considered as quite free from objection.

"Further, Kirchhoff has given a proof of the law in his Lectures [1894]; but against this, too, according to a remark of Boltzmann, objection may be made.

"In a different way the proof of this law was attempted in the first edition of this book. The weak points of this attempt were removed by N. N. Pirogoff [1885], and a varied form of Pirogoff's proof is given in the second of the Mathematical Appendices [of this book]" (p. 46.)

§ 34, on pressure of a gas in motion, and § 35, on reaction and cross-pressure, contain matter especially referred to in the preface as not in the first edition. They have perhaps nothing more quotable than the last paragraph of § 35, which is notable as including the only mis-translation that I have observed in the English edition. The paragraph reads, "Since these formulæ contains the velocity only in its square, they are independent of the direction of the motion, *and hold, therefore, as well for to-and-fro oscillations as for propagation of the longitudinal waves of sound.* On this depend the apparent attractions and repulsions in air when sounding and in the ribbed dust-figures of Kundt." The German of the lines which I have underscored is, "*gelten also auch für hin und her gehende Schwingungen, wie sie bei der Fortpflanzung der longitudinalen Schallwellen auftreten?*"

From § 38, on thermal effusion, "Just as effusion results from a difference of pressure at the two sides of a porous partition, so can a similar phenomenon be brought about by a difference of temperature of the two sides of a partition; and the latter phenomenon, according to Maxwell's suggestion, is called thermal effusion.

"The possibility of in this way producing a flow of gas by means of an unequal distribution of temperature, was first pointed out by Carl Neumann when he was attempting to explain the production of a thermo-electric current by analogy with a thermal diffusion."

CHAPTER IV.—*Ideal and Actual Gases.*

"From numerous observations which Galitzine has partly made by himself and partly drawn from other sources, the pressure of a mixture [of gases] is sometimes greater and sometimes less than the sum of the pressures exerted by the components separately" (p. 92). § 47 deals very briefly with attempts to improve upon the formula of van der Waals's.

CHAPTER V.—*Molecular and Atomic Energy.*

"That monatomic gaseous molecules also may be capable of oscillatory motions in their interior we may look upon as probable, since in their spectra whole series of different lines are found. But these motions, as we may assume in accordance with E. Wiedemann's observations, require so small an expenditure of energy that its amount does not come at all into account in comparison with the kinetic energy of the molecular motion.

"Hence monatomic molecules need in no way be rigid massive points; it is only necessary that they should be very small particles in whose interior only such motions can come into play as demand but very little energy. It therefore does not appear impossible that the ratio $C \div c = 1.67$ should be found in the case of chemically compound molecules also, if the connection of the atoms is so firm that internal motions are excluded" (p. 121).

The last quotation brings us near a very active crater of debate, the eruptions of which have been familiar to readers of English scientific periodicals for years; namely, the question of equal distribution of energy among the different degrees of freedom of a system. Into the general question Meyer does not go, but insists, as in his first edition, that, with such limited freedom as the atoms have within the molecule, the law of uniform distribution of energy among the various degrees of freedom does not generally hold. "We shall be inclined to consider the rule, that *in gases with polyatomic molecules the mean energy of an atom is smaller than the translatory energy of a molecule,* to be a veritable law of nature, which, like Boyle's and the other laws of gases, admits exceptions under certain circumstances" (p. 130). "Since the bonds of the atoms by which they are bound together in the molecule allow of neither perfect freedom nor perfect fastness, it does not seem admissible simply to count the kinds of movability" (p. 144).

CHAPTER VI.—*Molecular Free Paths.*

There is little new except in § 71, where the various hypotheses to account for the observed relations between temperature and mean free path are stated and that of Sutherland is discussed at some length.

CHAPTER VII.—*Viscosity.*

We find (p. 187) "From these measures [by Crookes] it resulted that Maxwell's law of the constancy of the coefficient of viscosity in actual gases holds down to pressures which are so small that they can no longer be measured with accuracy. Only at a much higher rarefaction there occurs a sudden drop in the value of the coefficient of viscosity." "Just as at very low pressures, so also at very high pressures, Maxwell's law of the constancy of viscosity-coefficient loses its strict validity." A slightly smaller value of the coefficient is now given than the one stated in the first edition.

"By the entrance of more atoms into the molecule the section πs^2 will in most cases increase, while the molecular speed will diminish; the interval T between successive collisions may therefore be constant. In this case the coefficient of viscosity must also be constant" * * * "Hence all gaseous substances which contain a large number of atoms in their molecule have nearly equal coefficients of viscosity" (p. 200).

§ 80, on viscosity of gaseous mixtures, deduces from theory a formula which is followed by this passage: "Puluj has made measurements of the internal friction of mixtures of carbonic acid and hydrogen, has compared his results with the formula, and has found a really good agreement. So, too, has Breitenbach. By these observations a striking fact was confirmed, which was first noticed by Graham as he allowed mixtures of hydrogen with other gases to flow through capillary tubes. Although the viscosity of hydrogen is less than that of carbonic acid, a slight admixture of hydrogen has the effect of increasing and not of decreasing the viscosity of carbonic acid; nor does a diminution begin until the mixture contains a largish amount of hydrogen."

In § 85, on the influence of temperature on viscosity, the views of Sutherland in regard to the effects of molecular attraction are again made prominent. "The reasons for the assumption that the sphere of action [of the molecule] diminishes as the temperature rises have been given." * * * "But in the question of actual gases, those attempts at explanation will certainly meet with most acceptance which do not assume a real diminution of the molecules or their spheres of action, but only an apparent alteration. From this point of view Sutherland's view deserves to be preferred to all others. According to him we have not to deal with the real sphere of action [that is, the sphere of which the radius is the smallest distance apart of the centres of the particles at the moment of collision], but with an apparent sphere which is [owing to intermolecular attraction] larger than the real one." "The amount of this enlargement depends on the speed with which the particles move, and, therefore, on the temperature of the gas; it is the greater the less the speed or the lower the temperature." "In bringing forward this hypothesis to explain the phenomena Sutherland had really the greatest success."

§ § 86–92, dealing with the viscosity of vapors and with viscosity as affected by dissociation, are made up of matter which did not appear in the first edition. They contain, perhaps, nothing more striking than the fact that condensation, occurring when a vapor, originally saturated, flows with some expansion through a small tube, makes the coefficient of viscosity, as estimated from rate of delivery, smaller than if the vapor were dry.

CHAPTER VIII.—*Diffusion.*

This chapter differs from the corresponding part of the first edition mainly by the introduction of Sutherland's use of molecular attractions and by a more detailed effort of the author to justify, from experimental results, his own contention that the coefficient of diffusion of two gases is variable with the proportions of the mixture. "*D* therefore assumes a different value at every different place in the mixture that is being formed by the diffusion" (p. 262). He admits that his own formula for *D* makes the calculation of diffusion 'excessively laborious,' and is charitable to those who have preferred to use a more convenient though, as he maintains, inaccurate one.

CHAPTER IX.—*Conduction of Heat.*

In his first edition the author derives from theoretical considerations the formula

$$k = 1.530\ \eta c,$$

where k is the thermal conductivity, η the coefficient of viscosity, and c the specific heat at constant volume. He now finds 1.6027 instead of 1.530. Other changes are indicated by the following quotations: "In fact, the assumption has many times been made, especially by Stefan and Boltzmann, that the kinetic energy of the molecular motion is passed on from place to place with greater speed than the remaining energy, which in Chapter V. we have termed the atomic energy. We were at that time obliged to yield to this view, because no other possibility was seen of bringing the theoretical law $k = \kappa\eta c$ into a complete agreement with the observations then published" (p. 284). But now, "The excellent agreement of the calculated and observed values". * * * "justifies in us, on the contrary, the conviction that the accuracy of the theoretically deduced relation between the conductivity and viscosity of gases is no longer to be doubted, and that we may take it as proved that a gas has the same conductivity for every kind of energy. From this result of theory we see finally that viscosity, diffusion, and conduction of gases depend in the same way on the free path of the gaseous particles, and that each of these three phenomena may be employed to determine the value of the molecular free path" (p. 296).

CHAPTER X.—*Direct Properties of Molecules.*

§§ 111 and 112 of this chapter carry further than the old edition does the argument in proof of the general flatness of molecules. "These examples seem to indicate that the section of a molecule is equal to the sum of the sections of the atoms which form it" (p. 302). "If the hypothesis were general and exact that the section of the molecule of a chemical compound is equal to the sum of the sections of its atoms, it would allow of but a *single* interpretation, and thereby permit an interesting peep into the circumstances of arrangement of the atoms. We should not be at liberty to make any other assumption than that the atoms which are bound together into one molecule are all in one plane" (p. 304). "When four atoms are joined together to form a molecule it is in general no longer necessary for them to possess the property of being a plane system; the possibility, however, of the system being of such a character is shown by the example of ammonia." * * * "We shall consequently be unable to make any other supposition as to the molecular constitution of ammonia than that usual with chemists, viz, that the three atoms of hydrogen are so arranged that their common centroid is always within the atom of nitrogen, and that they circle about this atom in plane orbits" (p. 305). "And so good an agreement is exhibited by the great majority of the values at 0° for gases and vapors that we have to conclude in general that *their molecules have a shape that is flat, and not spread out on all sides into space.* This view seems to be the most probable, at least for the gaseous state" (p. 309).

The last paragraph of § 116 reads thus: "From these considerations we can conclude only that the gaseous molecules are smaller than a sphere whose diameter is one-millionth of a millimetre. But we may add as very probable that the size of the gaseous molecules will in no way appear to be vanishingly small when compared with that small sphere. This is justified on many other grounds, which we have still to mention."

§ 118, on calculation of the size of the molecules from the dielectic capacity, is new. "The molecules of such substances [dielectrics] are assumed to be good conductors of electricity, while the interspaces between them are taken to be insulating. According to this assumption the dielectric polarisation must depend on the size and distance apart of the molecules, and therefore on the same elements which regulate the molecular free path" (p. 327).

§ 123, on molecular forces, makes near the end a more detailed reference to the work of E. Wiedemann on luminous vapors. "He compared the light radiated by sodium vapor with that coming from a platinum wire made to glow by the passage of an electric current; from the resistance of the wire and the strength of the current he could determine the luminous energy in heat units, and compare it with the total heat-energy contained in the vapor. He found that the energy needed for the illumination is vanishingly small in comparison with the total energy. An atom, therefore, must be a structure in which pendulous movements can be produced by very small forces."

§ 124 is an enthusiastic statement of the general features and possibilities of the vortex atom theory. It is probable that Meyer has never seen the letter written by Lord Kelvin to the late Professor Holman, which ends thus: "We may expect that the time will come when we shall understand the nature of an atom. With great regret I abandon the idea that a mere configuration of motion suffices."

This brings us to the mathematical appendices, which extend through 112 pages. The new matter in these is, for the most part, closely connected with the changes already noted in the earlier portions of the book. In several cases the changes in numerical values of important constants are based on the computations of Conrau.

The translation is well done, though an occasional awkward phrase may show that the translator's ear for English is slightly and temporarily dulled by attention to the original. Thus, on p. 264, 'much too little for there to be found in it,' on p. 270 'has concluded the law,' and on p. 250 'relation' * * * 'which' * * * 'did not succeed in disclosing itself with full clearness.'

EDWIN H. HALL.

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The Digestibility of American Feeding Stuffs. By WHITMAN H. JORDAN and FRANK H. HALL. U. S. Department of Agricultural, Office of Experiment Station, Bulletin No. 77. Pp. 100.

Since farm animals, like man, live not upon what they eat but upon what they digest and assimilate, data on the digestibility of the various feeding stuffs are essential for judging of their relative feeding value and for calculating rations for animals under different conditions. Experiments on this subject have formed quite a feature of the work of a number of the agricultural experiment stations of this country, and these experiments have accumulated until at present they furnish a comprehensive series of digestion coefficients. The Bulletin brings together the results of these digestion experiments up to the end of 1898, and summarizes them in convenient form for use. Of the 378 experiments compiled, many of which were made with a number of animals, 59 were with green fodders (grasses and corn), 34 with silage (largely of corn), 143 with dried fodders (hay, corn fodder, etc.), 8 with roots and tubers, 24 with grains and seeds, 62 with by-products (brans, gluten feeds or meal, oil meals, etc.), 1 with milk, and 47 with mixed rations. The digestion coefficients are first arranged according to the stations at which the experiments were made. They are then grouped by classes of feeding stuffs and by the kind of animal (cow, steer, sheep, pig or horse) used in making the experiment. The latter classification gives both the individual experiments and the averages for the different classes of material. It is therefore the one which will be most generally used in practice. In the light of the data presented, the effects of various factors on digestibility are considered at some length. Under this heading are included the influence of the kind and condition of the animal used, the stage of growth of the crops, the effect of drying and curing, ensiling, grinding, cooking and moistening of the feed, etc. In many cases the need of more extended data is evident before deductions can be safely drawn.

The general methods of conducting digestion experiments are described and discussed, together with the limitations of the present methods, and the application of digestion coefficients in practice.

The compilation represents a large amount of painstaking work and study on the part of its authors, but it was well worth the undertaking and will prove a valuable summary. It will make it possible to use American digestion coefficients quite generally, in place of the European ones which were for many years the main reliance. The compilation will also serve a useful purpose in showing the lines in which additional digestion experiments are needed to supplement the data already obtained, and in calling attention to feeding stuffs which have not been sufficiently studied as to their digestibility. E. W. ALLEN.

SOCIETIES AND ACADEMIES.

NEW YORK ACADEMY OF SCIENCES.

SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY.

A MEETING of the Section was held on Monday evening May 7th. Mr. Bergen Davis read a paper describing some new experiments in stationary sound waves. The experiments were in three groups, those with a sound wave anemometer, those with the use of empty gelatine medicine capsules instead of cork-dust to show the Kundt figures, and those concerning the longitudinal motion of a cylinder closed at one end across the stream lines in a stationary sound wave.

The stationary sound wave was that produced in a stopped organ pipe, provided with a glass panel for observation, when it was sounding its first overtone. A thin rubber diaphragm near the central node prevented air currents due to the blowing of the pipe. The cups of the miniature anemometer were made by dividing No. 2 gelatine capsules longitudinally so as to form half cylinders and mounting them on card-board arms. The anemometer rotated with ten revolutions per second in the loop of the wave and came nearly to rest in the node. The rate of revolution at various positions along the wave varied approximately according to a sine curve. The maximum amplitude of the wave as calculated from the above rate was .57 cm.

The Kundt's figure experiment was performed by emptying a box of No. 5 gelatine capsules into the middle of the loop. They arranged themselves in rows across the pipe. Each capsule attracted its neighbor at the ends and repelled it at the sides. The experiment is quite striking.

The motion of a cylinder perpendicularly to the stream lines was obtained by using a capsule from which the cap had been removed. Such a capsule moved in the direction of the closed end with considerable force. This was also shown by making a small mill with a capsule at the end of each of four card-board arms. The rates of revolution in various parts of the wave made, when plotted, nearly a sine curve. The force acting normally to the closed ends of the cylinders was measured with a torsion balance. The square roots of the torsion deflections gave, when plotted, an approximate sine curve. The experiment was performed in air, illuminating gas, carbon dioxide and hydrogen. The torsion deflections were directly proportional to the densities of the gases. Professor William Hallock first suggested the cause of this effect, showing that it was due to the principle of Bernouilli, that a gas in motion is less dense than the same gas at rest. The vibrating air has considerable velocity while the air within the cylinders is nearly at rest. The force is due to the difference of density on the two sides of the closed end of the cylinder. The author used this principle to determine the amplitude of vibration. Professor R. S. Woodward assisted him in applying the proper hydrodynamical principles, and he calculated that the change in density was such as to give a pressure of 21 dynes per square centimeter, while the amplitude was .33 centimeters. This agrees closely with the value obtained with the sound wave anemometer.

Professor Hallock also exhibited some color photographs and some sound wave photographs taken by Professor R. W. Wood, of the University of Wisconsin. WILLIAM S. DAY,
Secretary of Section.

SECTION OF ANTHROPOLOGY AND PSYCHOLOGY.

A REGULAR meeting of the Section was held on May 28th. The first paper, by G. B. Germann, on 'The Acquirement of Motor Habits' reported some experiments in which the author measured the degree of perfection attained in rapid naming of one hundred color squares arranged in regular order, by the time required to read the whole series. Results were presented for the rapidity of reading at different stages of practice and after different intervals of discontinuance of practice.

The second paper, by C. H. Judd, was on the subject 'Studies in Vocal Expression.' This paper reported measurements of changes in pitch during the articulation of single words. The pitch was determined by means of enlarged records of diaphragm vibrations which were compared with the tracing made from a standard tuning fork. Twenty records were reported. In general the accented syllable was higher in pitch than the unaccented syllables, though this was not true in such words as 'abhorrent' and 'abnormal.' The final syllable in the twenty records showed a very general tendency to fall off in pitch. The amount of change in such words as 'educing' and 'illusion' will appear from some cases of the former. The three syllables were as follows: case I., 161, 244, 171 (the end of the syllable being at 131); case II., 157, 255, 185 (end of syllable 125); case III., 172, 248, 166 (end of syllable 123). Other records did not show such marked changes. One for the word 'abasement' is as follows: 103, 150, 140.

Charles H. Judd,
Secretary.

THE NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

The June meeting of the New York Section of the American Chemical Society was held on the 8th inst., at the Chemists' Club.

The retiring chairman, Dr. Chas. F. McKenna, invited the president of the Society, Dr. William McMurtrie, to preside. An address was made by Dr. McKenna on the 'Advancement in the Study of the Properties of the Metals,' and on the 'Present and Future of the New York Section of the American Chemical Society.'

The election of officers for the ensuing year resulted as follows:

Chairman, Dr. C. A. Doremus.

Secretary and Treasurer, Durand Woodman.

Executive Committee, C. F. McKenna, M. T. Bogert, P. C. McIlhiney.

The following papers were then read:

'Comparison of Iodine and Bromine Figures of Various Fatty Oils,' by H. T. Vulté and Lily Logan.

'The Chemistry of Materials used in Perfumery and kindred Arts,' by T. C. Stearns.

'Rapid Method for Separation of Cadmium, Bismuth, etc., from Zinc and Manganese,' by George C. Stone.

'On the Oxidation of Platinum,' by Dr. R. C. Hall.

A motion was made and seconded that a fund should be raised for a prize for the best paper read before the Society during each season. This was in pursuance of a suggestion made by the chairman in his address.

Notice was given of the general meeting of the American Chemical Society, to be held in the latter part of the month, after which the Section adjourned.

Durand Woodman,
Secretary.

DISCUSSION AND CORRESPONDENCE.

PREHISTORIC REMAINS IN JAPAN.

To the Editor of Science: While in Okayama, Japan, in the early part of this month I was conducted by Rev. J. H. Pettee to the hills about two miles east of the city to see some prehistoric stone structures which he had noticed in his rambles. The first one to which we came was situated about 500 feet above the valley (which was nearly at sea level) near the summit of a steep declivity overlooking an extensive country. This was built of stones laid up in regular courses, some of them very large. One stone was 5x5x4½ feet. Large flat stones served for the roof. The entrance was twenty-one feet long, six feet wide and about twelve feet high. This opened into a room twelve feet long, of which the north side was flush with one of the walls of the entrance, making the entire length of this wall thirty-three feet. The room is twelve feet square, and about the same height.

The whole was covered with a mound of earth, upon which trees of considerable size were growing. This one had been cleaned out and put to some modern use. But the eight others which we visited, were in most cases partly or wholly filled with débris which had slowly accumulated in them. In size they differed greatly from one another, several of them were so small that they could not have served for habitations. When they occurred on the side hill they were covered with earth removed from the immediate vicinity. In the roofs of two of them we measured stones which were 9x7x3 and 10x5x4 feet respectively. In all, Mr. Pettee had found twenty of these structures in the immediate vicinity. It is hoped that more careful exploration will be made of those which are filled with débris. The present inhabitants have no knowledge of their origin, and they are entirely out of analogy with any structures of recent times.

In a communication made to the Japanese Asiatic Society of London, a few years ago (the date of which I do not remember) the writer spoke of having noted about four hundred such structures in different parts of the Empire, all substantially alike, but with minor modifications in shape, only a small portion of them having the wall of the entrance and the room flush on one side, like the one here observed. The few ornaments found in them were unlike anything of present Japanese manufacture.

At Yokohama, also, I was taken by Rev. Henry Loomis to see various rooms artificially excavated in the soft rock of the region which were evidently of ancient origin, as evinced by the character of the tool marks upon them. But more interesting still were two shell heaps, about one hundred and fifty feet above the bay, in which not only had most of the shells been artificially opened to procure the food, but there were numerous pieces of pottery of antique character. The situation of these was much the same as of those described by Professor Morse near Tokio.

The universality of such indications of a primitive culture preceding that of existing civilizations in Japanese as well as in Europe and America is certainly interesting and significant. Much further light is still in store from their systematic study.

G. FREDERICK WRIGHT.

NAGASAKI, JAPAN, April 23, 1900.

SEALS IN THE AMAZON DRAINAGE.

ON September 20, 1899, William J. Gerhard, a field entomologist, observed several seals in a stream among the headwaters of the Madiera river, in Bolivia. The exact locality was a small tributary of the Rio Secure, whose waters find their way into the Madiera by way of the Mamore river. From the position assumed by the seals, as described by Mr. Gerhard, it is evident they were members of the Otaridæ, and most probably either *Otaria jubata* or *Arctocephalus australis*.

This is, I believe, the first notice of any seal from the Amazon system.

JAMES A. G. REHN.

ACADEMY OF NATURAL SCIENCES,
PHILADELPHIA.

THE INTERNATIONAL CONGRESSES OF METEOROLOGY AND AËRONAUTICS AT PARIS.

TO THE EDITOR OF SCIENCE: As some of your readers may be planning to attend the International Congresses of Meteorology and Aëronautics this summer, at Paris, it seems proper for the official delegate of the United States to call attention to an error in the dates announced in SCIENCE of June 1st. These congresses will not meet during July but during September, the Meteorological Congress being held between the tenth and the sixteenth of that month and the Aëronautical Congress, fixed for nearly the same time on account of the allied interests, having its sessions from the fifteenth to the twentieth of September.

The mistake, which was made also by your English contemporary, *Nature*, probably arose from the fact that when the list of the various congresses was issued several months since, the dates of the two congresses in question had not been determined; nevertheless the blanks left in the date column were assumed to mean that each of these congresses coincided with the one immediately preceding it in alphabetical order.

A. LAWRENCE ROTCH.

BLUE HILL METEOROLOGICAL OBSERVATORY.
June 7, 1900.

THE NAME OF THE COCHINEAL.

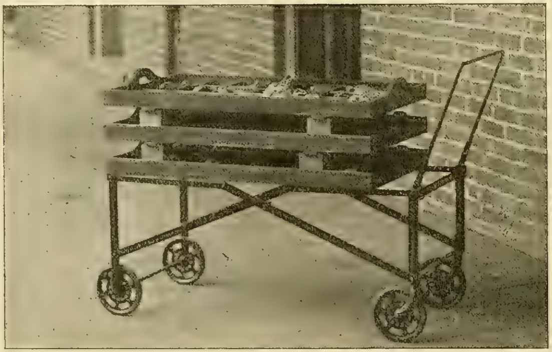
I HAVE elsewhere (*Proc. Acad. Nat. Sci.*, Phila., 1899, p. 261) shown that the *Coccus cacti*, Linné, is not the true cochineal, and that the latter insect belongs to the genus *Pseudococcus*, Westwood. I have lately had some correspondence with Professor and Mrs. Fernald of the Massachusetts Agricultural College, on the synonymy of this insect, and it seems that the only way to avoid confusion is to propose a new name for the *Coccus cacti* of Signoret, Essai sur les Cochenilles, p. 381; Newstead, *Ent. Mo. Mag.*, April, 1897, p. 76. It is therefore proposed to name the latter species *Pseudococcus signoreti.*

T. D. A. COCKERELL.

MESILLA PARK, N. M., May 28, 1900.

A TRUCK FOR MINERALS.

TO THE EDITOR OF SCIENCE: For the benefit of those teachers who have to move heavy specimens for purposes of illustration from museum to lecture room, I send you an account of a plan which for two years I have used here with great comfort to myself. For a truck I have a folding steel church truck, such as is used by funeral directors. This, when not in use, can be folded up and put aside, occupying very little space. For convenience I have attached a handle to one end, made by bending a piece of half inch iron rod twice at right angles, and bolting the two ends to the frame, with a locking device which holds it rigid when pushed against. The minerals or other specimens are placed in shallow wooden trays 18 x 36 inches, with the usual hand holes at the ends, and set upon the opened truck. If more than one tray full be needed, others may be added by using wooden bridges, made by nailing to each end of a thin strip a little longer than the width of the tray, a square block notched below to fit the side of the tray. This contrivance makes a temporary frame on which the second tray rests securely, high enough above the first to be out of the way of the specimens. With another pair of bridges another tray can be added, and so on till the load is complete. One load of these on the truck trays is shown in the figure. The steel trucks are very strong and are guaranteed to sustain a weight of 500 pounds. They are provided with rubber-tired, ball-bearing wheels—those at one end being swiveled, and with full load they are very easily pushed or pulled and guided around



the ends of cases. With an arrangement for holding books, trucks of this kind would certainly be a great convenience to librarians also.

EUGENE A. SMITH.

UNIVERSITY, ALA., May 26, 1900.

THE ECLIPSE OF MAY 28TH.

THE party from Vassar College selected Wadesboro, N. C., as the station of observation for the solar eclipse of May 28th, because of its favorable weather prognostication, and because other parties having a large and varied equipment were stationed there. The instruments used by us were a three-inch Clark telescope, and a pair of field glasses of two inches aperture, with a direct-vision spectroscope attached to one eye-piece. The three-inch telescope was to be used in comparing the color of the prominences. With this purpose in view, a low power was employed, so that the entire rim of the hidden sun could be seen at once. Cross wires at focus served for locating the prominences in position angle. Tachini and a few others have seen what appeared to be white prominences. Whether this was a real phenomenon or a psychological effect has been questioned, and among the twelve observations proposed by the eclipse committee of the Astronomical and Astrophysical Society, one upon prominence color was included, in order that a general effort to note color might lead to more definite conclusions. Purkinje's investigations have shown that the brightest prominences should look the reddest. Therefore, slight variations in redness would not necessarily indicate difference in constitution. Miss Furness is familiar with the appearance of a prominence as seen in the hydrogen line of the spectrum. She noted no marked difference in color in the several prominences seen around the sun's limb during eclipse. A variation toward the pink was clearly observable in one small prominence in the S. E. quadrant. A very large and beautiful prominence in the form of the banyan tree was observed in the S. W. quadrant. This was of the usual red color.

The direct vision spectroscope attached to the field-glass was a McClean star spectroscope, with the cylindrical lens removed. The object in view was to examine the distribution of coronium. It has been claimed that the green line of coronium is as plainly discernible in the rifts of the corona as in the streamers. With the simple apparatus above described (first suggested by Mr. Maunder) if it is properly adjusted, and if the continuous spectrum of the inner corona is not too bright, the question of distribution might be well tested. If the coronium is confined to the regions determined by the visible outline of the corona, the green image in the one glass would correspond in form to the composite image in the other. If, on the contrary, the coronium is equally distributed in streamers and rifts, the green image would indicate this by its uniformity of outline. Our apparatus was tested by examining an opening of the form of the corona, cut in cardboard, and held before a Bunsen flame, emitting sodium and lithium light. The red and yellow images were sharply defined.

The observation during totality was, however, without decided result. The continuous spectrum of the inner corona was so bright that the green image could not be separated from it. Clear separation being found impossible, attention was turned to the regions above and below the continuous spectrum limits, to note, if possible, any green extensions. These could not be seen, though the brightness of the field might have rendered this doubtful in any case. Probably the dispersion of the prisms was insufficient. The inner corona was much more brilliant than I had expected.

MARY W. WHITNEY.
VASSAR COLLEGE.

NOTES ON INORGANIC CHEMISTRY.

AT the recent meeting of the Iron and Steel Institute of Great Britain a number of very interesting papers were read, which are abstracted in *Nature* and from which we make note of the following:

A paper by Mr. B. Talbot on the open-hearth continuous steel process as introduced in the Pencoyd Steel Works in Pennsylvania. Here a basic tilting furnace of seventy-five tons capacity is used, and is charged at once with fluid metal, at a great saving of fuel and time. The general advantages of the furnace were stated to be increased output, increased yield, saving in repair, and saving in labor. A long discussion followed the paper and the opinion was general that this process represented an important advance in open-hearth steel practice.

A description was given by Mr. A. Greiner of the first blowing-engine worked by blast-furnace gas. This is a 600 H. P. engine at the Cockerill works, Belgium, and has been running since last November with unpurified gases from the Seraing blast furnace.

Mr. C. von Schwarz discussed the manufacture of cement from blast-furnace slag. Various attempts at the utilization of the slag in the past have met with little success, but now a method has been devised and is in use in Germany and Belgium whereby the cement manufactured commands a higher price in the market than ordinary Portland cement.

An apparatus for equalizing the temperature of the hot blasts was described by Mr. L. F. Gjers and Mr. J. H. Harrison. Instead of the blast going directly from the stoves to the tuyers, whereby the temperature falls continuously from the turning on of one stove until a fresh stove is used, the blast passes from the stove through another small stove filled with checker work, and while entering on one side with varying temperature, it leaves the small stove at an even mean temperature.

The affairs of the Institute were shown to be in a very flourishing condition, 110 members being added during the year. The Bessemer gold medal for 1900 was presented to M. Henri de Wendel, the eminent French metallurgist, in recognition of his services to metallurgy in developing the iron ore resources of French and German Lorraine.

Mr. Andrew Carnegie announced his intention of founding a scholarship in connection with the Institute, for the advancement of research in connection with iron and steel.

The same number of *Nature* gives an account of the Royal Society Converzazione of May 9th, but there appear to have been few exhibits in the line of chemistry. Professor W. A. Shenstone showed a quantity of crude non-splintering silica for use in apparatus of silica, recently described in these notes, and also several rods, tubes, a Giessler tube and a mercury thermometer of silica. Dr. Thorpe exhibited some examples of leadless glazed ware, and Mr. H. B. Hartley and Mr. H. L. Bowman gave a demonstration of the properties of crystals yielding double-refracting liquids on fusion. These substances, among which are para-azoxyanisol, para-azoxyphenetol, and cholesteryl benzoate, when fused give liquids which possess the properties of double refraction and dichroism, although the evidence of their elasticity, viscosity, and dielectric capacity shows them to be undoubtedly liquids.

Apropos of Professor Shenstone's work on fused quartz a paper has appeared in the *Proceedings* of the Royal Dublin Society, by Professor J. Joly, on the 'Theory of the Formation of Silicates in Igneous Rocks,' in which he discusses the temperature range of the viscosity of quartz. He finds that when heated to 800° quartz becomes plastic and that as high as 1500° it is a thick liquid. This softening point is much lower than is commonly supposed, and makes it easier to understand the facility with which it is worked by Professor Shenstone. At the same time it lends more encouragement to the hope of a wide use of quartz for apparatus.

No little comment has been occasioned, especially in England, by the publication in the *Zeitschrift für angewandte Chemie* of a lecture delivered before the German Emperor by Professor Bredt. The title of the lecture was 'Technical Education and the Importance of Scientific Training,' and statistics were given of the three great dye-stuff factories of Germany. From these it appears that the Badische Anilin- und Sodafabrik, of Ludwigshafen, employs 6207 workmen, including 146 chemists and 75 engineers. The Farbewerke vorm. Meister Lucius und Brüning of Höchst am Main and the Farbenfabriken vorm. Fr. Bayer & Co., of Elberfeld, each employ 130 chemists. With these facts before one, it is not difficult to understand that Germany leads the world in dye stuffs.

J. L. H.

NOTES ON PHYSICS.

THE FREEZING POINT OF WATER AND PRESSURE.

In the *Annalen der Physik* for May, 1900, G. Tammann describes some remarkable experimental studies of the variation of the freezing-point of water with pressure. It appears that that there are three kinds of ice differing from each other in crystalline structure. Counting these three kinds of ice, five forms of water are now known, namely, vapor, liquid, ice I. (common ice), ice II., and ice III. A given pair of these forms (phases) of water can exist together in equilibrium only at definite temperatures and pressures. That is, for a given temperature the pressure at which two phases may coexist is definite. Thus ice I. and water coexist at 0°C. under atmospheric pressure, at —3°.7C. under 500 atmospheres, at — 8°.4C. under 1000 atmospheres, etc. These pairs of temperatures and pressures represented by ordinates and abscissas determine a curve. This curve is called the *transition curve* (umwandlungs curve) for water and ice. Herr Tammann has followed the transition curve for water and ordinary ice far beyond the region previously known, in fact throughout its entire extent, and he has determined portions of the transition curves of water and ice II., of water and ice III., of ice I. and ice II., and of ice I. and ice III. He has also determined the latent heats of fusion of ice II. and of ice III., the latent heats of transition from ice I. to ice II. and from ice I. to ice III., and the changes of volume during these various transitions.

READERS of SCIENCE who are not familiar with recent work in physical chemistry may be interested to know that many solid substances are known which have two or more forms (phases). Thus, very recently, it has been found that metallic tin may exist as a gray crystalline powder or in the well known form having lustre and ductility. At a certain temperature (under atmospheric pressure) these two phases may coexist in equilibrium, at higher temperatures the ductile variety only is stable, and at lower temperatures the gray crystalline form only is stable.

SOME EXPERIMENTS WITH POLARIZED LIGHT.

THE *Annalen der Physik* for May, 1900, contains a description by N. Vmow of several beautiful and instructive experiments with polarized light.

A polished cone of glass stands upon a flat white screen. A beam of ordinary light parallel to the axis of the cone is reflected by the curved surface of the cone forming a circle of light around the base of the cone upon the white screen. If the beam of light is plane polarized the circle of light will have a broad dark streak across it. If a quartz plate is placed in the path of the plane polarized beam the planes of polarization of the various wavelengths will be differently turned and the circle of light around the base of the cone will consist of radial bands of color in the order red, orange, yellow, green, blue, violet, purple.

A plane polarized beam of light is reflected down through milky water (obtained by mixing a small portion of an alcoholic solution of rosin with the water) contained in a glass cylinder. To a person walking around the cylinder the water would appear bright then dark then bright then dark again. The two opposite directions from which the milky water appears bright mark the plane of polarization of the beam of light. If now a quartz plate is interposed in the path of the polarized beam the planes of polarization of the various wavelengths will be differently turned and the milky water will appear to be streaked with vertical bands of color. A milky solution of sugar substituted for the water (quartz plate removed) shows a series of helical bands of color.

ON THE SIZE AT WHICH HEAT MOVEMENTS ARE MANIFESTED IN MATTER.

IN his characteristically suggestive way Professor G. F. Fitzgerald, in *Nature*, April 26th, raises the question as to the maximum dimensions of a space in which the heat movements of a portion of a body in thermal equilibrium might deviate sensibly from the steady average which these movements show on a large scale. The heat movements of matter do not show their erratic character in a space large enough to be resolved by the microscope, but Professor Fitzgerald points out that the accompanying ether motions are much more coarse grained and may give rise to sensible phenomena; thus the so-called Brownian motions of small particles immersed in a liquid may be caused by the erratic character of heat motions in small regions. He suggests further that these erratic heat motions may have something to do with the vitality of diatoms. Indeed *it is physically possible* that a living cell may not be subjected to the second law of thermodynamics. If so, in what way would a diatom be expected to show its freedom from this law? Very likely in not being dependent upon food for the maintenance of its vitality, and the biologist may sometime show us an organism which can live in the dark without food.

W. S. F.

WEATHER CONDITIONS IN NEW YORK CITY AT THE END OF JUNE.

THROUGH the kindness of Professor Willis L. Moor, Chief of the Weather Bureau, we are able to give figures regarding the temperature and precipitation in New York City during next week, which will prove of interest to those attending the meeting of the Association.

The daily mean temperature since 1885 has been as follows:

June.	24	25	26	27	28	29	30
1885	68°	69°	69°	70°	69°	69°	65°
1886	63	67	70	71	68	71	67
1887	70	71	70	73	72	77	79
1888	83	80	76	73	59	60	70
1889	68	70	72	75	77	78	72
1890	73	78	76	68	72	72	74
1891	71	76	81	64	68	69	66
1892	72	71	72	70	72	72	76
1893	70	67	57	62	62	66	71
1894	72	67	76	78	78	74	77
1895	72	72	68	64	68	72	71
1896	59	58	68	72	64	71	66
1897	71	76	65	64	67	72	76
1898	71	78	80	74	72	72	76
1899	75	72	74	74	72	68	70
Mean	70.5	71.5	71.6	70.1	69.3	70.9	71.7

The daily amount of rain in inches and hundredths has been:

June.	24	25	26	27	28	29	30
1885					0.58	0.02	
1886	0.04		*T*				
1887	0.13						
1888		0.30	0.49		0.63	0.18	*T*
1889		*T*	0.03		*T*		*T*
1890							
1891							
1892	0.01	0.36		0.10	0.08		0.23
1893			0.89	0.17	*T*		
1894	0.01	*T*		*T*		*T*	0.06
1895	0.09	0.03	*T*	0.67	0.23	0.66	0.10
1896	0.66	0.55	0.19		0.09		
1897						*T*	0.12
1898		0.13			0.22	*T*	
1899	*T*	0.63			0.03	0.68	

The mean daily temperature is about 2° lower than would be the case in the third week in August, and it may be expected consequently to be considerably less hot during the day time than would be the case if the meeting were in August. The chances of rain are about the same.

REORGANIZATION IN THE GEOLOGICAL SURVEY.

THE geological work of the United States Survey was originally organized in grand geographic divisions for each of which there was a geologist-in-charge, having complete authority over his assistants. After many years of trial this system was found to be expensive, both of means and talent, and was replaced by the temporary expedient of a large number of independent parties reporting immediately to the director. Administratively this plan has worked very satisfactorily, but it lacked scientifically the element of co-operation between distinct parties. To effect this co-ordination of scientific results in each important specialty of geology, the following organization has now been adopted, as stated in the draft of plans for the current year, approved by the Secretary of the Interior.

Six geologists have been appointed as geologists in charge of special subjects of research, the six subjects covering the whole field of geology in the Survey. These assignments are as follows:

T. C. Chamberlin, geologist in charge of pleistocene geology; George F. Becker, geologist in charge of physical and chemical research; S. F. Emmons, geologist in charge of investigation of metalliferous ores; C. Willard Hayes, geologist in charge of investigation of non-metalliferous economic deposits; Bailey Willis (assistant in geology to the director), geologist in charge of areal geology.

These assignments are based upon the necessity for closer supervision and co-ordination of the growing geologic work of the Survey. The personnel of the geologic branch will be classed as geologists in charge, geologists, and assistant geologists. Administrative control of the two former classes shall in each individual case be immediate with the director. Assistant geologists will report through their chiefs. Scientific direction will be the duty of the geologists in charge, each in his special section, and shall be accomplished by appropriate conference in the office and supervision in the field.

The total appropriation for geologic work for 1900–1901 is $163,700. To this are added from the State of Pennsylvania $2000, and from the State of New York $1000, sums appropriated for co-operation in geology with the Federal Survey, and on condition that in each case a like amount be expended from the Federal appropriation for work in the State. The total amount available for geologic surveys is therefore $166,700.

SCIENTIFIC NOTES AND NEWS.

THE University of Toronto has conferred the degree of doctor of laws on Professor Simon Newcomb, U. S. N.

CAMBRIDGE UNIVERSITY proposed to confer on June 12th the degree of LL.D. on Professor S. P. Langley of the Smithsonian Institution, and on M. Poincaré, the Paris mathematician.

AMONG the honorary degrees conferred on June 14th at the commencement of the Western University of Pennsylvania, the Sc. D. was given to O. A. Leuschner, professor of astronomy, University of California, and to Wm. W. Campbell, senior astronomer, Lick Observatory.

PROFESSOR A. P. COLEMAN, of the University of Toronto, and Dr. H. M. Ami, of the paleontological staff of the Geological Survey of Canada, Ottawa, were elected Fellows of the Royal Society of Canada at its last meeting held in Ottawa, May 28–31, 1900.

PROFESSOR H. F. OSBORN, of Columbia University and the American Museum of Natural History, has been invited to succeed the late Professor Cope as vertebrate paleontologist of the Geological Survey of Canada.

WE regret to learn that Dr. Henry Sidgwick, for nearly thirty years professor of moral philosophy at Cambridge University, is compelled to resign his chair owing to ill-health. Professor Sidgwick is at present sixty-two years of age and is well known as one of the greatest English writers on ethics and political science.

ON May 3d the completion of the twenty-fifth year of teaching by Professor Luciani, rector of the University of Rome, was celebrated in the physiological laboratory of the university. Addresses were made by Professors Todaro and Baccelli and Professor Luciani replied.

PROFESSOR IRA REMSEN, of the Johns Hopkins University, will give the commencement address at the Tome Institute, Port Deposit, Md.

SPECIAL preparations are being made in the American Museum of Natural History for the reception of members of the American Association. President Jesup has issued an invitation to all the local members for Tuesday evening, June 26th, and a similar invitation will be mailed to visiting members immediately upon their registration. Members will be admitted on the closed days, Monday and Tuesday, upon showing their tickets or badges. The curators will be ready to assist in showing the various exhibits. The newest hall is that of Mexican archæology under the direction of Professor J. W. Putnam and Mr. Saville. The Fossil Mammal Hall has recently received a large number of additions, both in fossil mammals and reptiles. A full series of photographs of the museum has recently been made, and will be placed on exhibition in the lower hall.

THE Society for Plant Morphology and Physiology is to hold a special meeting at the Museum Building, New York Botanical Garden, on Wednesday, June 27th, at 4 p. m., to receive the report of the committee (appointed in December at the New Haven meeting) upon improvement of reviews of botanical literature. The question of concerted action upon the subject with the other botanical societies will be considered.

THE Scientific Society of Danzig offers on the occasion of the 150th anniversary of its establishment, a prize of 1000 Marks for a paper on the geology of North Germany.

THE Peabody Academy of Science receives $10,000 by the will of the late Walter S. Dickson.

THE late Baron Adolphe-Charles de Rothschild bequeathed property bringing in an income of $50,000 a year for the establishment of an ophthalmological hospital at Paris. He also bequeathed his fine collection of objects of art to the Louvre with $60,000 to defray the cost of arranging them for exhibition.

THE Paris Pasteur Institute will offer in November, in its new quarters in the rue Dutot, courses of instruction including lectures, conferences and laboratory work. They will include bacteriological methods of analyzing physiological and pathological products, etc.

MR. W. E. D. SCOTT, curator of the ornithological department in Princeton, announces that the British Museum has presented to the university two thousand mounted birds, specimens from India, Australia and the Malay Islands. Some time ago the university presented the British Museum with 250 sets of North American birds' eggs.

MR. P. M. MUSSER has given $30,000 for a public library at Muscatine, Ia.

THE Norwegian steamer *Antarctic*, with the Danish East Greenland expedition commanded by Lieut. Amdrup, sailed from Copenhagen on June 14th, to explore the coast between Cape Brewster and Agga Island.

THE *Engineering and Mining Journal* of June 9th publishes the full tables of mineral and metal production of the United States in 1899, as prepared for the *Mineral Industry*, Volume VIII. This production, valued at the mines or furnaces, amounted to $1,211,361,861, the largest amount on record for the United States or any other country. Deducting certain necessary duplications, the net value of the mineral production in 1899 was $1,118,780,830, against $799,518,033 in 1898, showing an increase last year of $319,262,797, or 39.9 per cent. This great amount came partly from the increase in quantities and partly from general advances in values. The United States last year was the greatest producer of coal, salt, iron, copper, silver and lead in the world; also of many of the less important metals and minerals. The extent of our production is shown by the figures, which include 252,115,387 short tons of coal; 13,400,735 long tons of pig iron; 581,319,091 pounds of copper; 217,085 tons of lead; 129,675 tons of zinc; 57,126,834 ounces of silver, and $70,096,021 in gold.

MOVEMENTS started simultaneously in London by the Royal Geographical Society and in the British Central Africa Republic under the leadership of Sir Henry Stanley for the erection of a memorial near the spot where Livingstone died on Lake Bangweula, resulted in the formation of a joint committee for purposes of co-operation. The work of the committee as we learn from the London *Times* has now been accomplished. The materials with which to construct the memorial having been shipped to the mouth of the Zambesi. The monument consists of a handsome obelisk 20 feet in height, surmounted by a cross. It is constructed of large blocks of the best concrete, which will be quite as enduring as the hardest stone. No stone is available in this part of Africa. The concrete was sent out in air-tight metal cylinders, of which there are 450, each weighing about 50 pounds. These are accompanied by 30 moulds of oak, lined with metal, 18 inches square and about 10 inches deep. Over 300 of these blocks will be used in the construction of the memorial. Two tablets of blackened bronze will be firmly embedded in blocks as they are being moulded, and will be placed on opposite sides of the obelisk. These will contain the following inscription:

> Erected by his friends to the memory of Dr. David Livingstone, missionary and explorer. He died here, May 4, 1873.

Two other tablets will be placed on the other faces of the memorial, with the following inscription:

> This monument occupies the spot where formerly stood the tree at the foot of which Livingstone's heart was buried by his faithful native followers. On the trunk was carved the following inscription:—David Livingstone. Died May 4th, 1873. Chuma, Souza, Mniasere, Uchopere.

THE extensive repairs on the Peary Arctic Steamer *Windward* which have been in progress for several months are now completed and the steamer will sail from Sydney about July 1st in command of Captain Samuel W. Bartlett. The New York *Evening Post* states that the *Windward* will proceed directly, with a call at Disko, to Etah, North Greenland, Captain Peary's winter quarters, where instructions from him will doubtless be found, or if not, will be awaited. It will take with her the maximum quantity of coal, additional lumber, oil, sugar, arms, ammunitions, provisions, scientific instruments and everything which is necessary for Mr. Peary's work, including two new whale-boats, built at New Bedford, for the Peary service, thoroughly equipped in every detail. Upon the arrival of the *Windward* at Etah, Mr. Peary will assume command, and further movements will be subjected to the conditions of his work and to his instructions. No passengers will be taken on the *Windward*, the Danish Government having qualified their permission to land at the Greenland ports, with conditions that tourists should not be carried.

REUTER'S AGENCY has received a letter from Major St. H. Gibbons, who is engaged on a trans-African expedition, dated 'North Moera Lake, January 21st,' in which the explorer says: "I reached the neighborhood of Nanakundundu with native canoes early in October, but failed to procure carriers to follow the route I intended to take—viz, to the Zambesi source and thence along the watershed into the Congo eastwards. Thus I was compelled to make the journey with four boys and five donkeys. After traveling thus for 420 miles, during which I lost two donkeys, who were killed by lions, I caught up the Lemaire-Katanga Scientific Expedition. I overtook Captain Lemaire near the Mumbeje river and travelled with him east to the Lufira system, and thence northeast to the Congo State station on the Lukafu river. I have been treated with the greatest cordiality by Captain Lemaire and by all the State officials with whom I have come in contact. The objects of the expedition have so far been carried out *in toto*, and I am now on my way home by forced marches *via* Lado and Khartum. From where I now am this route will probably prove as quick as *via* either the east or west coast. The main reason why, after abandoning the northern route in favor of the west on the paralyzation of the main supplies with the steamers occasioned by Mr. Muller's death and Mr. Weller's loss of health, I have again returned to the original plans laid down is that I wish to examine the country between here and the Nile for the purpose of giving Mr. Rhodes such information as may be helpful to him in connection with his railway and telegraph schemes in Africa. I continue my journey north to-morrow, and expect to reach Lado in April. Thence I shall descend the Nile as best I can."

IT is stated in the *British Medical Journal* that next autumn with the co-operation of the Mediterranean, Adriatic, and Sicilian Railway Companies, the Società per gli Studi della Malaria will make experiments on a large scale as to the prevention of malarial fever among railway servants in malarious districts in Italy. At all the stations which bear the worst name in regard to this scourge the huts in which the men and the families live will be protected with mosquito netting in the way which proved so successful last year in the Prenestina-Cervara and Magliana-Pontegalera lines. Similar experiments will be made on the Foggia-Barletta and Battipaglia-Reggio lines, on the Pontine Marshes, and in Sicily. Systematic examinations of the blood of sufferers from malaria will also be made in the hospitals of Milan and Crema, with the object of studying the course of the fever in Lombardy. Research stations will be established at Cumignano on the Naviglio in the province of Cremona for the study of malaria in its relation to rice fields, and in the province of Ferrara for the study of the disease in its relation to brackish waters and the maceration of textile plants. Another station will be established at Trinitapolis in the province of Foggia for the study of malaria in the south of Italy, and probably one in the Venetian district. Similar investigations will be pursued in Sicily and Sardinia. By this combination of research it is hoped to gain an accurate idea of the regional distribution and local characteristics of malaria in Italy, and to find means of prevention adopted to the condition of the different parts of the country.

UNIVERSITY AND EDUCATIONAL NEWS.

BY the will of Edmund Dwight $125,000 has been left to Harvard University after the death of persons who receive the income during life.

IT is said that over $900,000 have now been subscribed towards the endowment fund of Brown University, and the completion of the million dollars will probably be announced at the commencement exercises.

SOME months ago Mr. Rockefeller offered $100,000 to Denison University upon the condition that $150,000 additional be raised before July 1st of this year. At the commencement exercises, June 14th, it was announced that the required amount has been subscribed, and, in addition, enough more to bring the total of the present increase in the productive endowment up to $300,000. It was announced, at the same time, that Shepardson College for Women, also located at Granville, O., has been formally incorporated into Denison University, making the latter practically co-educational. As thus reorganized, Denison University includes the following schools: Granville College, Shepardson College, The Conservatory of Music, The School of Fine Arts, The School of Military Science, Doane Academy.

Mr. Morris K. Jesup has given $25,000 to Princeton University for an object not specified.

Mr. R. M. Stimson has given to Marietta College his library containing about 20,000 volumes.

Mr. W. S. Stratton has given $50,000 to Colorado College.

Messrs. Phelps, Dodge & Co. have contributed $10,000 to a special fund for the endowment of the departments of mining and metallurgy at Columbia University, and smaller sums have been contributed to the same fund.

A gift of $25,000 to Lombard College in Galesburg, Ill., by William G. Waterman of Galena, Ill., and another gift of $8000 by Judge Sylvanus Wilcox of Elgin, nearly complete the $100,000 semi-centennial fund of the college.

The opening of Rochester University to women seems now practically assured, as of the $50,000 required for that purpose $40,000 have already been secured.

Lyman C. Smith, a citizen of Syracuse, and a trustee of Syracuse University, will build and equip a civil engineering building for that institution.

The department of geology, of Harvard University, offers, in connection with the work of the summer school, an advanced course in geological field-work in New York and Connecticut. The work in the corresponding course last summer was in Montana and the Yellowstone Park. The summer excursion for practical observations of mining will begin as soon after the final examinations as possible, and will last six weeks. Instead of the usual trip to the Lake Superior iron region, the tour this summer will be to the anthracite coal mines of Pennsylvania and the iron mines of the Lake Champlain district.

The degrees conferred by the University of Toronto at its recent commencement were as follows: Ph.D., 1; M.A., 17; LL.B., 2; M.B., 45; B.A., 134; C.E., 2; Mg.E., 1; Mech.E., 1; B.A.Sc., 10; D.D.S., 68; Ph.M.B., 34; Mus. Bac., 3.

At the recent meeting of the Regents of the University of Nebraska, Dr. Bessey, acting chancellor, reported the enrollment in the several colleges as follows:

The Graduate School,	148.
The College of Literature, Science and Arts,	923.
The Industrial College,	585.
The College of Law,	161.
The College of Fine Arts (Schools of Art and Music),	366.
Summer School,	282.

After deducting duplicate names, the total enrollment for the college year is 2205, of which 1229 are men and 976 women.

At the commencement exercises on June 7th, degrees were conferred as follows:

Bachelor of Arts,	89.
Bachelor of Science,	34.
Bachelor of Law,	65.
Master of Arts,	28.
Doctor of Philosophy,	1.

Certificates of graduation from the School of Music, 9; University Teachers' Certificates, 31; Certificates in Mechanic Arts, 2; Certificates in Physical Training, 2.

At the University of Nebraska the following appointments have been made: Carl Christian Engberg, Ph.D. (Nebraska), to be instructor in mathematics. Clarence Aurelius Skinner, Ph.D. (Berlin), adjunct professor in physics, in place of Dr. Louis Trenchard More, resigned. John Edwin Almy, M.A. (Nebraska), and Ph.D. (Berlin), to be instructor in physics, in place of Dr. Skinner, promoted. Dr. John White has been advanced to the professorship of general and analytical chemistry. The twenty-five appointments to fellowships include the following:

Botany.—George Grant Hedgcock, William Titus Horne, Cora Frances Smith, John Lewis Sheldon.

Electrical Engineering.—Herbert Silas Evans.

Geology.—Cassius Asa Fisher, A.B.

Mathematics.—Louis Siff.

Pedagogy.—William R. Hart.

Philosophy.—Frederick Henry Kuhlmann.

Zoology.—Frank Elbert Watson.

SCIENCE

FRIDAY, JUNE 29, 1900.

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MSS. intended for publication and books, etc., intended for review should be sent to the responsible editor, Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

*RHYTHMS AND GEOLOGIC TIME.**

CUSTOM dictates that in complying with the rule of the Association I shall address you on some subject of a scientific character. But before doing so I may be permitted to pay my personal tribute to the honored and cherished leader of whose loss we are so keenly sensible on this occasion. His kindly personality, the charm which his earnestness and sincerity gave to his conversation, the range of his accomplishment, are inviting themes; but it is perhaps more fitting that I touch this evening on his character as a representative president of this body. The Association holds a peculiar position among our scientific organizations of national or continental extent. Instead of narrowing its meetings by limitations of subject matter or membership, it cultivates the entire field of research and invites the interest and co-operation of all. It is thus not only the integrating body for professional investigators, but the bond of union between these and the great group of cultured men and women—the group from whose ranks the professional guild is recruited, through whom the scientific spirit is chiefly propagated, and through whose interest scientific research receives its financial support. Its aims and form of organization recognize, what pure science

* Read to the American Association for the Advancement of Science at New York, June 26, 1900, as the address of the retiring President.

does not always itself recognize, that pure science is fundamentally the creature and servant of the material needs of mankind, and it thus stands for what might be called the human side of science. Edward Orton, throughout his career as teacher and investigator, was conspicuous for his attention to the human side of science. His most abstract work was consciously for the benefit of the community, and he ever sought opportunity to make its results directly available. In promoting the interests of the people of his adopted state he incidentally accomplished much for a larger community by helping it to an appreciation of the essential beneficence of the scientific study of nature and man. As an individual he was a diligent and successful laborer in the field which the Association cultivates, and when the Association selected him as its standard bearer it made choice of one who was peculiarly its representative.

The subject to which I shall invite your attention this evening is by no means novel, but might better be called perennial or recurrent; for the problem of our earth's age seems to bear repeated solution without loss of vigor or prestige. It has been a marked favorite, moreover, with presidents and vice-presidents, retiring or otherwise, when called upon to address assemblies whose fields of scientific interest are somewhat diverse—for the reason, I imagine, that while the specialist claims the problem as his peculiar theme of study he feels that other denizens of the planet in question may not lack interest in the early lore of their estate.

The difficulty of the problem inheres in the fact that it not only transcends direct observation but demands the extrapolation or extension of familiar physical laws and processes far beyond the ordinary range of qualifying conditions. From whatever side it is approached the way must be paved by postulates, and the resulting views are so discrepant that impartial onlookers have come to be suspicious of these convenient and inviting stepping stones.

That vain expectation may not be aroused I admit at the outset that I have not solved the problem and shall submit to you no estimates. My immediate interest is in the preliminary question of the available methods of approach, and it leads to the consideration of the ways, or the classes of ways, in which the measurement of time has been accomplished or attempted.

Of the artificial devices employed in practical horology there are two so venerable that their origins are lost in the obscurity of legendary myth. These are the clepsydra and the taper. In the clepsydra advantage is taken of the approximately uniform rate at which water escapes through a small orifice, and time is measured by gaging the loss of water from a discharging vessel or the gain in a receiving vessel. The hour glass is one of its later forms, in which sand takes the place of water. The taper depends for its value as a time piece on the approximate uniformity of combustion when the area of fuel exposed to the air is definitely regulated. It survives chiefly in the prayer stick and safety fuse, but the graduated candle is perhaps still used to regulate monastic vigils.

The pendulum, a comparatively modern invention, excelling the clepsydra and taper in precision, has altogether supplanted them as the servant of civilization. Its accuracy results from the remarkable property that the period in which it completes an oscillation is almost exactly the same, whatever the arc through which it swings. It regulates the movements not only of our clocks, watches and chronometers, but of barographs, thermographs and a great variety of other machines for recording events and changes in their proper order and relation in respect to time.

I must mention also a special apparatus invented by astronomers and called a chronograph. It consists ordinarily of a revolving drum about which a paper is wrapped and against which rests a pen. As the drum turns the pen draws a line on the paper. Through an electric circuit the pen is brought under the influence of a pendulum in such a way that at the middle of each swing of the pendulum the pen is deflected, making a mark at right angles to the straight line. The series of marks thus drawn constitutes a time scale. The electric arrangements are so made that the pen will also be disturbed in consequence of some independent event, such as the firing of a gun or the transit of a star; and the mark caused by such disturbance, being automatically platted on the time scale, records the time of the event.

No attempt has been made to characterize these various time pieces with fullness, because they are already well known to most of those present, and, in fact, the chief motive for giving them separate mention is that they may serve as the basis of a classification. In the use of the clepsydra and taper, time is measured in terms of a continuous movement or process; in the use of the pendulum time is measured in terms of a movement which is periodically reversed. The classification embodies the fundamental distinction between continuous motion and rhythmic motion.

Passing now from the artificial to the natural measures of time we find that they are all rhythmic. It is true that the spinning of the earth on its axis is in itself a continuous motion, but it would yield no time measure if the earth were alone in space, and so soon as the motion is considered in relation to some other celestial body it becomes rhythmic. As viewed from, or compared with, a fixed star the period of its rhythm is the sidereal day; compared with the sun it is the solar day, nearly four minutes longer; and compared with the moon it is the lunar day, still longer by 49 minutes. As the sun supplies the energy for most of the physical and all the vital processes of the earth's surface, the rhythm of the solar day is impressed in multitudinous ways on man and his environment, and he makes it his primary or standard unit of time. He has arbitrarily divided it into hours, minutes and seconds, and in terms of these units he says that the length of the sidereal day is a little more than 23 hours, 56 minutes and 4 seconds, and the average length of the lunar day is a little less than 24 hours and 49 minutes. The lunar day finds expression in the tides and is of moment to maritime folk, but the sidereal is known only to astronomers.

Next in the series of our natural time units is the month, or the rhythmic period of the moon regarded as a luminary. By our savage ancestors, who credited the moon with powers of great importance to themselves, much use was made of this unit, but as progress in knowledge has shown that the influence of the satellite had been vastly overrated, less and less attention has been paid to the returning crescent, and it is only in ecclesiastic calendars that the chronology of civilization now recognizes the natural month. Its shadow survives, without the substance, in the calendar month; and the week possibly represents an early attempt to subdivide it.

In passing to our third natural unit, the year, we again encounter solar influence, and find the rhythm of the earth's orbit echoed and reechoed in innumerable physical and vital vibrations. As the attitude of the earth's axis inclines one hemisphere toward the sun for part of the year and the other hemisphere for the remainder, the whole complex drama of climate is annually enacted, and the sequence of man's activities is made to assume an annual rhythm. The year is second only to the day as a terrestrial unit of duration; and as the day is man's standard for the minute division of time, so the year is his standard for larger divisions, and the decade, the century and the millenium are its multiples.

But the rhythms of day and night, of summer and winter, are not the only tides in the affairs of men. At birth we are small, weak and dependent, we grow larger and stronger, we become mature and independent, and then by reproducing our kind we complete the cycle, which begins again with our children. The cycle of human life is the *generation*, a time unit of somewhat indefinite length and varying in phase from family to family, but holding a place, nevertheless, in human chronology.

Still less definite is the rhythm of hereditary rulership, progressing from vigor through luxury to degeneracy, and closing its cycle in usurpation; yet it makes an epoch in the life of a nation or empire, and so the *dynasty* is one of the units of the historian.

The generation and the dynasty are of waning importance in human chronology, and they can claim no connection with the problem of geologic time; but here again I have turned aside for a moment in order to illustrate a principle of classification. The daily rhythm of waking and sleeping, of activity and rest, does not originate with man but is imposed on him by the rhythm of light and darkness, and that in turn springs from the turning of the earth in relation to the shining sun. The yearly rhythm of sowing and harvesting, of the fan and the furnace, does not originate with man but is imposed on him by the rhythm of the seasons, and that in turn springs from certain motions of the earth in relation to the glowing sun. But the rhythm of the generation and the rhythm of the dynasty have origin in the nature of man himself. The rhythms of human chronology may thus be grouped according to source in two classes, the *imposed* and the *original;* and the same distinction holds for other rhythms. The lunar day is an original rhythm of the earth as seen from the moon; the ground swell is an original rhythm of the ocean; but the tide is an imposed rhythm of the ocean, being derived from the lunar day. The swing of the pendulum is an original rhythm, but the regular excursion of the chronograph pen, being caused by the swing of the pendulum, is an imposed rhythm.

In giving brief consideration to each of the more important ways by which the problem of the earth's age has been approached, I shall mention first those which follow the action of some continuous process, and afterward those which depend on the recognition of rhythms.

The earliest computations of geologic time, as well as the majority of all such computations, have followed the line of the most familiar and fundamental of geologic processes. All through the ages the rains, the rivers and the waves have been eating away the land, and the product of their gnawing has been received by the sea and spread out in layers of sediment. These layers have been hardened into rocky strata, and from time to time portions have been upraised and made part of the land. The record they contain makes the chief part of geologic history, and the groups into which they are divided correspond to the ages and periods of that history. In order to make use of these old sediments as measures of time it is necessary to know either their thickness or their volume, and also the rate at which they were laid down. As the actual process of sedimentation is concealed from view, advantage is taken of the fact that the whole quantity deposited in a year is exactly equalled by the whole quantity washed from the land in the same time, and measurements and estimates are made of the amounts brought to the sea by rivers and torn from the cliffs of the shore by waves. After an estimate has been obtained of the total annual sedimentation at the present time, it is necessary to assume either that the average rate in past ages has been the same or that it has differed in some definite way.

At this point the course of procedure divides. The computer may consider the aggregate amount of the sedimentary rocks, irrespective of their subdivisions, or he may consider the thicknesses of the various groups as exhibited in different localities. If he views the rocks collectively, as a total to be divided by the annual increment, his estimate of the total is founded primarily on direct measurements made at many places on the continents, but to the result of such measurements he must add a postulated amount for the rocks concealed by the ocean, and another postulated amount for the material which has been eroded from the land and deposited in the sea more than once.

If, on the other hand, he views each group of rocks by itself, and takes account of its thickness at some locality where it is well displayed, he must acquire in some way definite conceptions of the rates at which its component layers of sand, clay and limy mud were accumulated, or else he must postulate that its average rate of accretion bore some definite ratio to the present average rate of sedimentation for the whole ocean. This course is, on the whole, more difficult than the other, but it has yielded certain preliminary factors in which considerable confidence is felt. Whatever may have been the absolute rate of rock building in each locality, it is believed that a group of strata which exhibits great thickness in many places must represent more time than a group of similar strata which is everywhere thin, and that clays and marls, settling in quiet waters are likely to represent, foot for foot, greater amounts of time than the coarser sediments gathered by strong currents; and studying the formations with regard to both thickness and texture, geologists have made out what are called *time ratios*,—series of numbers expressing the relative lengths of the different ages, periods and epochs. Such estimates of ratios, when made by different persons, are found to vary much less than do the estimates of absolute time, and they will serve an excellent purpose whenever a satisfactory determination shall have been made of the duration of any one period.

Reade has varied the sedimentary method by restricting attention to the limestones, which have the peculiarity that their material is carried from the land in solution; and it is a point in favor of this procedure that the dissolved burdens of rivers are more easily measured than their burdens of clay and sand.

An independent system of time ratios has been founded on the principle of the evolution of life. Not all formations are equally supplied with fossils, but some of them contain voluminous records of contemporary life; and when account is taken of the amount of change from each full record to the next, the steps of the series are found to be of unequal magnitude. Though there is no method of precisely measuring the steps, even in a comparative way, it has yet been found possible to make approximate estimates, and these in the main lend support to the time ratios founded on sedimentation. They bring aid also at a point where the sedimentary data are weak, for the earliest formations are hard to classify and measure. It is true that these same formations are almost barren of fossils, but biologic inference does not therefore stop. The oldest known fauna, the Eocambrian, does not represent the beginnings of life, but a well advanced stage, characterized by development along many divergent lines; and by comparing Eocambrian life with existing life the paleontologist is able to make an estimate of the relative progress in evolution before and after the Eocambrian epoch. The only absolute blank left by the time ratios pertains to an azoic age which may have intervened between the development of a habitable earth crust and the actual beginning of life.

Erosion and deposition have been used also, in a variety of ways, to compute the length of very recent geologic epochs. Thus, from the accumulation of sand in beaches Andrews estimated the age of Lake Michigan, and Upham the age of the glacial lake Agassiz; and from the erosion of the Niagara gorge the age of the river flowing through it has been estimated. But while these discussions have yielded conceptions of the nature of geologic time, and have served to illustrate the extreme complexity of the conditions which affect its measurement, they have accomplished little toward the determination of the length of a geologic period; for they have pertained only to a small fraction of what geologists call a period, and that fraction was of a somewhat abnormal character.

Wholly independent avenues of approach are opened by the study of processes pertaining to the earth as a planet, and with these the name of Kelvin is prominently associated.

As the rotation of the earth causes the tides, and as the tides expend energy, the tides must act as a brake, checking the speed of rotation. Therefore the earth has in the past spun faster than now, and its rate of spinning at any remote point of time may be computed. Assuming that the whole globe is solid and rigid, and that the geologic record could not begin until that condition had been attained, there could not have been great checking of rotation since consolidation. For if there had been, it would have resulted in the gathering of the oceans about the poles and the baring of the land near the equator, a condition very different from what actually obtains. This line of reasoning yields an obscure outer limit to the age of the earth.

On the assumption that the globe lacks something of perfect rigidity, G. H. Darwin has traced back the history of the earth and the moon to an epoch when the two bodies were united, their separation having been followed by the gradual enlargement of the moon's orbit and the gradual retardation of the earth's rotation; and this line of inquiry has also yielded an obscure outer limit to the antiquity of the earth as a habitable globe.

One of the most elaborate of all the computations starts with the assumption that at an initial epoch, when the outer part of the earth was consolidated from a liquid condition, the whole body of the planet had approximately the same temperature; and that as the surface afterward cooled by outward radiation there was a flow of heat to the surface by conduction from below. The rate of this flow has diminished from that epoch to the present time according to a definite law, and the present rate, being known from observation, affords a measure of the age of the crust. The strength of this computation lies in its definiteness and the simplicity of its data; its weakness in the fact that it postulates a knowledge of certain properties of rock—namely, its fusibility, conductivity and viscosity—when subjected to pressures and temperatures far greater than have ever been investigated experimentally.

A parallel line of discussion pertains to the sun. Great as is the quantity of heat which that incandescent globe yields to the earth, it is but a minute fraction of the whole amount with which it continually parts, for its radiation is equal in all directions, and the earth is but a speck in the solar sky. On the assumption that this immense loss of heat is accompanied by a corresponding loss of volume, the sun is shrinking at a definite rate, and a computation based on this rate has told how many millions of years ago the sun's diameter should have been equal to the present diameter of the earth's orbit. Manifestly the earth can not have been ready for habitation before the passage of that epoch, and so the computation yields a superior limit to the extent of geologic time.

Before passing to the next division of the subject—the computations based on rhythms—a few words may be given to the results which have been obtained from the study of continuous processes. Realizing that your patience may have been strained by the kaleidoscopic character of the rapid review which has seemed unavoidable, I shall spare you the recitation of numerical details and merely state in general terms that the geologists, or those who have reasoned from the rocks and fossils, have deduced values for the earth's age very much larger than have been obtained by the physicists, or those who have reasoned from earth cooling, sun cooling and tidal friction. In order to express their results in millions of years the geologists must employ from 3 to 5 digits, while the physicists need but 1 or 2. When these enormous discrepancies were first realized it was seen that serious errors must exist in some of the observational data or else in some of the theories employed; and geologists undertook with zeal the revision of their computations, making as earnest an effort for reconciliation as has been made a generation earlier to adjust the elements of the Hebrew cosmogony to the facts of geology. But after rediscussing the measurements and readjusting the assumptions so as to reduce the time estimates in every reasonable way—and perhaps in some that were not so reasonable—they were still unable to compress the chapters of geologic history between the narrow covers of physical limitation; and there the matter rests for the present.

The rocks which were formed as sediments show many traces of rhythm. Some are composed of layers, thin as paper, which alternate in color, so that when broken across they exhibit delicate banding. In the time of their making there was a periodic change in the character of the mud that settled from the water. Others are banded on a larger scale; and there are also bandings of texture where the color is uniform. Many formations are divided into separate strata, as though the process of accretion had been periodically interrupted. Series of hard strata are often separated by films or thin layers of softer material. Strata of two kinds are sometimes seen to alternate through many repetitions. Borings in the delta of the Mississippi show soils and remains of trees at many levels, alternating with river silts. The rock series in which coal occurs are monotonous repetitions of shale and sandstone. Belgian geologists have been so impressed by the recurrence of short sequences of strata that they have based an elaborate system of rock notation upon it.

Passing to still greater units, the large aggregates of strata sometimes called systems show in many cases a regular sequence, which Newberry called a 'circle of deposition.' When complete, it comprises a sandstone or conglomerate, at base, then shale, limestone, shale and sandstone. This sequence is explained as the result of the gradual encroachment, or transgression, as it is called, of the sea over the land and its subsequent recession.

In certain bogs of Scandinavia deep accumulations of peat are traversed horizontally by layers including tree stumps in such way as to indicate that the ground has been alternately covered by forest and boggy moss. The broad glaciers of the Ice age grew alternately smaller and larger—or else were repeatedly dissipated and reformed—and their final waning was characterized by a series of halts or partial re-advances, recorded in concentric belts of ice-brought drift. Of these belts, called moraines of recession, Taylor enumerates seventeen in a single system.

In explanation of these and other repetitive series incorporated in the structure of the earth's crust, a variety of rhythmic causes have been adduced; and mention will be made of the more important, beginning with those which have the character of original rhythms.

A river flowing through its delta clogs its channel with sediment and from time to time shifts its course to a new line, reaching the sea by a new mouth. Such changes interrupt and vary sedimentation in neighboring parts of the sea. Storms of rain make floods, and each flood may cause a separate stratum of sediment. Storms of wind give destructive force to the waves that beat the shore, and each storm may cause the deposit of an individual layer of sediment. Varying winds may drive currents this way and that, causing alternations in sedimentation.

To explain the forest beds buried in the Mississippi silts it has been suggested that the soft deposits of the delta from time to time settled and spread out under their own weight. Various alternations of strata, and epecially those of the coal measures, have been ascribed to successive local subsidences of the earth's crust, caused by the addition of loads of deposit. It has been suggested also that land undergoing erosion may rise up from time to time because relieved of load, and the character of sediment might be changed by such rising. Subterranean forces, of whatever origin, seemingly slumber while strains are accumulating, and then become suddenly manifest in dislocations and eruptions, and such catastrophes affect sedimentation.

A more general rhythm has been ascribed to the tidal retardation of rotation and the resulting change of the earth's form. If the body of the earth has a rather high rigidity, we should expect that it would for a time resist the tendency to become more nearly spherical, while the water of the ocean would accommodate itself to the changing conditions of equilibrium by seeking the higher latitudes. Eventually, however, the solid earth would yield to the strain and its figure become adjusted to the slower rotation, and then the mobile water would return. Thus would be caused periodic transgressions by the sea, occurring alternately in high and low latitudes.

Another general rhythm has been recently suggested by Chamberlin in connection with the hypothesis that secular variations of climate are chiefly due to variations of the quantity of carbon dioxide in the atmosphere.* The system of interdependent factors he works out is too complex for presentation at this time, and I must content myself with saying that his explanation of the moraines of recession involves the interaction of a peculiar atmospheric condition with a condition of glaciation, each condition tending to aggravate the other, until the cumulative results brought about a reaction and the climatic pendulum swung in the opposite direction. With each successive oscillation the momentum was less, and an equilibrium was finally reached.

Few of these original rhythms have been used in computations of geologic time, and it is not believed that they have any positive value for that purpose. Nevertheless, account must be taken of them, because they compete with imposed rhythms for the explanation of many phenomena, and the imposed rhythms, wherever established, yield estimates of time.

The tidal period, or the half of the lunar

*An attempt to frame a working hypothesis of the cause of glacial periods on an atmospheric basis. *Journ. Geol.*, Vol. VII., 1899.

day, is the shortest imposed rhythm appealed to in the explanation of the features of sedimentation. It is quite conceivable that the bottom of a quiet bay may receive at each tide a thin deposit of mud which could be distinguished in the resulting rock as a papery layer or lamina. If one could in some way identify a rock thus formed, he might learn how many half-days its making required by counting its laminæ, just as the years of a tree's age are learned by counting its rings of growth.

The next imposed rhythm of geologic importance is the year. There are rivers, like the Nile, having but one notable flood in each year, and so depositing annual layers of sediment on their alluvial plains and on the sea beds near their mouths. Where oceanic currents are annually reversed by monsoons, sedimentation may be regularly varied, or interrupted, once a year. Streams from a glacier cease to run in winter, and this annual interruption may give a definite structure to resulting deposits. It is therefore probable that some of the laminæ or strata of rocks represent years, but the circumstances are rarely such that the investigator can bar out the possibility that part of the markings or separations were caused by original rhythms of unknown period.

The number of rhythms existing in the solar system is very large, but there are only two, in addition to the two just mentioned, which seem competent to write themselves in a legible way in the geologic record. These are the rhythms of precession and eccentricity.

Because the earth's orbit is not quite circular and the sun's position is a little out of the center, or eccentric, the two hemispheres into which the earth is divided by the equator do not receive their heat in the same way. The northern summer, or the period during which the northern hemisphere is inclined toward the sun, occurs when the earth is farthest from the sun, and the northern winter occurs when the earth is nearest to the sun, or in that part of the orbit called perihelion. These relations are exactly reversed for the southern hemisphere. The general effect of this is that the southern summer is hotter than the northern, and the southern winter is colder than the northern. In the southern part of the planet there is more contrast between summer and winter than in the northern. The sun sends to each half the same total quantity of heat in the course of a year, but the difference in distribution makes the climates different. The physics of the atmosphere is so intricate a subject that meteorologists are not fully agreed as to the theoretic consequences of these differences of solar heating, but it is generally believed that they are important, involving differences in the force of the winds, in the velocity and course of ocean currents, in vegetation, and in the extent of glaciers.

Now, the point of interest in the present connection is that the astronomic relations which occasion these peculiarities are not constant, but undergo a slow periodic change. The relation of the seasons to the orbit is gradually shifting, so that each season in turn coincides with the perihelion; and the climatic peculiarities of the two hemispheres, so far as they depend on planetary motions, are periodically reversed. The time in which the cycle of change is completed, or the period of the rhythm, is not always the same, but averages 21,000 years. It is commonly called the precessional period.*

Assuming that the climates of many parts of the earth are subject to a secular cycle, with contrasted phases every 10,500

* Strictly speaking, 21,000 years is the period of the precession of the equinoxes as referred to perihelion; but the perihelion is itself in motion. As referred to a fixed star the precession of the equinoxes has an average period of about 25,700 years.

years, we should expect to find records of the cycle in the sediments. A moist climate would tend to leach the calcareous matter from the rock, leaving an earthy soil behind, and in a succeeding drier climate the soil would be carried away; and thus the adjacent ocean would receive first calcareous and then earthy sediments. The increase of glaciers in one hemisphere would not only modify adjacent sediments directly, but, by adding matter on that side would make a small difference in the position of the earth's center of gravity. The ocean would move somewhat toward the weighted hemisphere, encroaching on some coasts and drawing down on others; and even a small change of that sort would modify the conditions of erosion and deposition to an appreciable extent in many localities.

Blytt ascribed to this astronomic cause the alternations of bog and forest in Scandinavia, as well as other sedimentary rhythms observed in Europe; and it has seemed to me competent to account for certain alternations of strata in the Cretaceous formations of Colorado. Croll used it to explain interglacial epochs, and Taylor has recently applied it to the moraines of recession.

The remaining astronomic rhythm of geologic import is the variation of eccentricity. At the present time our greatest distance from the sun exceeds our least distance by its thirtieth part, but the difference is not usually so small as this. It may increase to the seventh part of the whole distance, and it may fall to zero. Between these limits it fluctuates in a somewhat irregular way, in which the property of periodicity is not conspicuous. The effect of its fluctuation is inseparable from the precessional effect, and is related to it as a modifying condition. When the eccentricity is large the precessional rhythm is emphasized; when it is small the precessional effect is weak.

The variation of eccentricity is connected with the most celebrated of all attempts to determine a limited portion of geologic time. In the elaboration of the theory of the Ice age which bears his name, Croll correlated two important epochs of glaciation with epochs of high eccentricity computed to have occurred about 100,000 and 210,000 years ago. As the analysis of the glacial history progresses, these correlations will eventually be established or disproved, and should they be established it is possible that similar correlations may be made between events far more remote.

The studies of these several rhythms, while they have led to the computation of various epochs and stages of geologic time, have not yet furnished an estimate either of the entire age of the earth or of any large part of it. Nevertheless, I believe that they may profitably be followed with that end in view.

The system of rock layers, great and small, constituting the record of sedimentation, may be compared to the scroll of a chronograph. The geologic scroll bears many separate lines, one for each district where rocks are well displayed, but these are not independent for they are labelled by fossils and by means of these labels can be arranged in proper relation. In each time line are little jogs—changes in kind of rock or breaks in continuity—and these jogs record contemporary events. A new mountain was uplifted, perhaps, on the neighboring continent, or an old uplift received a new impulse. Through what Davis calls stream piracy a river gained or lost the drainage of a tract of country. Escaping lava threw a dam across the course of a stream, or some Krakatoa strewed ashes over the land and gave the rivers a new material to work on. The jogs may be faint or strong, many or few, and for long distances the lines may run smooth and straight; but so long as the jogs are irregular they give no clue to time. Here and there, however, the even line will betray a regularly recurring indentation or undulation, reflecting a rhythm and possibly significant of a remote pendulum whose rate of vibration is known. If it can be traced to such a pendulum there will result a determination of the rate at which the chronograph scroll moved when that part of the record was made; and a moderate number of such determinations, if well distributed, will convert the whole scroll into a definite time scale.

In other words, if a sufficient number of the rhythms embodied in strata can be identified with particular imposed rhythms, the rates of sedimentation under different circumstances and at different times will become known, and eventually so many parts of geologic time will have become subject to direct calculation that the intervals can be rationally bridged over by the aid of time ratios.

For this purpose there is only one of the imposed rhythms of practical value, namely, the processional; but that one is, in my judgment, of high value. The tidal rhythm can not be expected to characterize any thick formation. The annual is liable to confusion with a variety of original rhythms, especially those connected with storms. The rhythm of eccentricity, being theoretically expressed only as an accentuation of the precessional, can not ordinarily be distinguished from it. But none of these qualifications apply to the precessional. It is not liable to confusion with the tidal and annual because its period is so much longer, being more than 2000 times that of the annual. It has an eminently practical and convenient magnitude, in that its physical manifestation is well above the microscopic plane, and yet not so large as to prevent the frequent bringing of several examples into a single view. It is also practically regular in period, rarely deviating from the average length by more than the tenth part.

From the greater number of original rhythms it is distinguished, just as from the annual and tidal, by magnitude. The practical geologist would never confuse the deposit occasioned by a single storm, for example, with the sediments accumulated during an astronomic cycle of 20,000 years. But there are other original rhythms, known or surmised, which might have magnitudes of the same general order, and to discriminate the precessional from these it is necessary to employ other characters. Such characters are found in its regularity or evenness of period, and in its practical perpetuity. The diversion of the mouth of a great river such as the Hoang Ho or the Mississippi, might recur only after long intervals; but from what we know of the behavior of smaller streams we may be sure that such events would be very irregular in time as well as in other ways. The intervals between volcanic eruptions at a particular vent or in a particular district may at times amount to thousands of years, but their irregularity is a characteristic feature. The same is true of the recurrent uplifts by which mountains grow, so far as we may judge them by the related phenomena of earthquakes; and the same category would seem to hold also the theoretically recurrent collapse of the globe under the strains arising from the slowing of rotation. The carbon-dioxide rhythm, know as yet only in the field of hypothesis, is hypothetically a running-down oscillation, like the lessening sway of the cradle when the push is no longer given.

But the precessional motion pulses steadily on through the ages, like the swing of a frictionless pendulum. Its throb may or may not be caught by the geologic process which obtains in a particular province and in a particular era, but whenever the conditions are favorable and the connection is made, the record should reflect the persistence and the regularity of the inciting rhythm.

The search of the rocks for records of the ticks of the precessional clock is an out-of-door work. Pursued as a closet study it could have no satisfactory outcome, because the printed descriptions of rock sequences are not sufficiently complete for the purpose; and the closet study of geology is peculiarly exposed to the perils of hobby-riding. A student of the time problem cannot be sure of a persistent, equable sedimentary rhythm without direct observation of the characters of the repeated layers. He needs to avail himself of every opportunity to study the series in its horizontal extent, and he should view the local problem of original *versus* imposed rhythm with the aid of all the light which the field evidence can cast on the conditions of sedimentation.

Neither do I think of rhythm seeking as a pursuit to absorb the whole time and energy of an individual and be followed steadily to a conclusion; but hope rather that it may receive the incidental and occasional attention of many of my colleagues of the hammer, as other errands lead them among cliffs of bedded rocks. If my suggestion should succeed in adding a working hypothesis or point of view to the equipment of field geologists, I should feel that the search had been begun in the most promising and advantageous manner. For not only would the subject of rhythms and their interpretations be advanced by reactions from multifarious individual experiences, but the stimulus of another hypothesis would lead to the discovery of unexpected meanings in stratigraphic detail.

It is one of the fortunate qualities of scientific research that its incidental and unanticipated results are not infrequently of equal or even greater value than those directly sought. Indeed, if it were not so there would be no utilitarian harvest from the cultivation of the field of pure science.

In advocating the adoption of a new point of view from which to peer into the mysterious past, I would not be understood to advise the abandonment of old standpoints, but rather to emulate the surveyor, who makes measurement to inaccessible points by means of bearings from different sides. Every independent bearing on the earth's beginning is a check on other bearings, and it is through the study of discrepancies that we are to discover the refractions by which our lines of sight are warped and twisted. The three principal lines we have now projected into the abyss of time miss one another altogether, so that there is no point of intersection. If any of them is straight, both the others are hopelessly crooked. If we would succeed we should not only take new bearings from each discovered point of vantage, but strive in every way to discover the sources of error in the bearings we have already attempted.

G. K. Gilbert.

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*THE EIGHTH GROUP OF THE PERIODIC SYSTEM AND SOME OF ITS PROBLEMS.**

I.

In the early work of Newlands and of Mendeléeff, which subsequently developed into the periodic law, a serious difficulty was met with in dealing with iron, cobalt, nickel, and the metals of the platinum group. In Newlands' modified statement of his law of octaves he says: "The numbers of analogous elements, *when not consecutive*, differ by seven or by some multiple of seven." Thus we find him grouping† cobalt and nickel under a single number; so rhodium and ruthenium; so also platinum and iridium. Cobalt, nickel, palladium, plati-

*Address by the Vice-President and Chairman of Section C., American Association for the Advancement of Science, June, 1900.

† *Chem. News*, 13, 130 (1866).

num and iridium are considered by him analogous elements, each occupying the first place in the octave to which it belongs; iron, rhodium, ruthenium and gold are analogous elements, each occupying the seventh place in its octave; while osmium is included with copper and silver as the second members of their octaves. There was here an easily recognized inconsistency which was not cleared up till many years later Seubert was led by the study of the periodic law to revise the atomic weights of these metals.

In his first summing up of the principles of the periodic law in 1869, Mendeléeff concludes that "elements which are similar as regards their chemical properties have atomic weights which are either of nearly the same value (*e. g.*, platinum, iridium, osmium) or which increase regularly (*e. g.*, potassium, rubidium, cesium)"*. So in most schemes for representing the periodic system, each triplet of these elements is considered as a single element, and because even then they do not seem to fall into regular periodic arrangement, they are cast out, Ishmael-like, into an anomalous eighth group. This is doubtless the reason they have been relatively so much neglected by chemists, and possibly it is not incorrect to say that the chemistry of these metals is less known than that of any other group of well characterized elements. Yet there are certainly no nine nearly related elements which present so many interesting chemical problems, whose solution will so much further our knowledge of chemistry in general. It is the purpose of this address to attract the attention of the members of this Section to this group and some of its many problems.

The ordinary division of these nine metals is into three groups, viz, the common metals, iron, cobalt, and nickel, with an atomic weight of from 56 to 59 and a specific gravity of 7.8 to 8.9; the lighter platinum metals, ruthenium, rhodium and palladium, with an atomic weight 101.5 to 106.5 and a specific gravity of about 12; and the heavy platinum metals, osmium, iridium and platinum, of atomic weight 191 to 195 and specific gravity 21.5 to 22.5.

Jour. Phys. Chem. Soc. Russ., 1 (1869), 60.

Of these metals, iron alone can be considered abundant and was the only one known until the eighteenth century. The ores of cobalt and nickel have been known for over two centuries, but the probable presence of a new metal in cobalt ore was first pointed out by Brandt* in 1735, and nineteen years later Cronstedt† determined the existence of nickel. Both of these discoveries were several decades after confirmed by Bergman‡.

It is, however, a curious and interesting fact that a coin of Bactria § of a date more than two centuries before Christ has been found containing twenty per cent. of nickel and hence quite similar in composition to our modern 'nickels.' There seem, however, to be no references in ancient literature which would indicate that attention was ever attracted by nickel or any of its compounds.

Turning to the platinum metals, the first recognized mention of platinum seems to be in the 'Relacion historica' of Don Antonio de Ulloa (vol. 1, lib. vi, cap. 10, p. 606) published first in 1748, the book being an account of the French expedition of 1735 to the western coast of South America to measure an arc of the meridian on the equator. The passage reads: "In the district of Chocó (Columbia) which contains many placer mines, are also found some, the gold of which, occurring mixed with other substances as metals and rocks, or

* *Akta Reg. Soc. Sci. Upsala* (1735), 33.

† *K. Svenska Vet. Akad. Handl.* (1751), 293.

‡ *Opusc. Diss.* 20 (1775), 24 (1780) 12 and 14, 25 (1779) 31 and 33.

§ *Ann. der Phys.* (Pogg.), 139, 507 (1870).

being enveloped in them, requires the use of quicksilver for its extraction; and sometimes ores are found which are not worked because of the *Platina* in them (a mineral of such resistance that it is not easy to break it, nor to crush it upon an anvil), for this substance is not affected by calcination, nor is there any means of extracting the metal which it contains, except at the cost of much labor and expense.

From the mention here made, platinum is evidently a well-known substance, and it is by no means improbable that earlier definite mention of platinum may yet be found. In this connection it is interesting to note that there have been many efforts to show that platinum was known at much earlier periods. Scherer* considers from a passage in Balbin's History of Bohemia (P. I., ch. xiv., p. 4) that platinum was known to the Bohemian Jesuits toward the end of the seventeenth century, occurring in the Riesengebirge, for he speaks of a kind of gold so white that one would swear it was silver,† were it not for its weight, ductility, infusibility and insolubility in nitric acid. Julius Scaliger's 'Exercitationes Exotericae de Subtilitate,' published at Frankfort in 1601, makes mention of an infusible metal found in the mines of Mexico and Darien, which might seem to indicate platinum.‡ There have been, moreover, a number of efforts to show that platinum was known to antiquity, under the names of *electrum* or of *plumbum candidum*. Cortinovis § considers that the electrum of the ancients was platinum, and proves it to his own satisfaction from the Bible, from classic historians of nature and art, from poetry and from Homer.* A similar view is held by Schweigger,† where Pausanius (5, chap. 12, p. 406. Ed. Casaub.) is quoted as mentioning electrum, from which Augustus had made columns, as occurring in nature in the sands of the river Eridanus, and as being very rare, hence much more valuable than the other kind of electrum which is merely an alloy of silver and gold. In 1850 Paravey makes ‡ a strong effort to show that Pliny when speaking in his Natural History of *plumbum candidum*, refers to platinum. Pliny speaks indeed of a lead, heavier and more ductile than gold and in Book 34, Chapter 16, gives a definite description of it. To use the quaint translation of Philemon Holland, Doctor of Physicke, published first in 1601:

"Now insueth the discourse of lead, and the nature of it; of which there be two principall kindes, the blacke, and the white. The richest of all, and that which carrieth the greatest price, is that which we in Latine name Plumbum candidum, *i. e.* the white bright lead and the Greeks Cassiteron. But I hold it a meere fable and vaine tale, that all of it is fetched as farre as from the Islands of the Atlanticke Sea, and that the inhabitants of those parts doe conveigh it in little twiggen boats, couered all ouer with feathers. For the truth is that there is found of it in these daies within Portugall and Gallaecia, growing ebbe upon the opmost face of the earth, being among the sands, of a black colour, and by the weight only is knowne from the rest of the soile: and here and there among, a

* *Allg. J. Chem.* (Scherer), 6, 633 (1801).

† Aurum album, quod argentum esse jurares, nisi auro familiares proprietates aliud suaderent, pondus scilicet, extensibilitas, vis eludendi ignem et aquam fortem, solubilitas in aqua regia, etc.

‡ Praeteria scito infunduribus, qui tractus est inter Mexicum et Darien, fodinas esse auricalchi, quod nullo igni, nullis hispanicis artibus, hac tenus liquescere potuit.

§ Opuscoli Scelti Sulla Scienze, etc. Milano, 1760.

* As an instance of the views of Cortinovis may be cited the lines:

Atria cinxit ebur, trabibus solidatur ahenis
Culmen et in celsas surgunt *electra* columnas,

from Claudian's 'Rape of Proserpina' (Book I., v. 164) where it is considered that *electrum* must mean platinum.

† *J. prakt. Chem.*, 34, 385 (1845).

‡ *Compt. Rend.*, 31, 179 (1850).

man shall meet with small stones of the same stuffe, most of all within the brookes, that be dry sometimes of the yere. This sandie and grauelly substance, the mine masters and mettall finers use to wash, and that which settleth downeward, they burne and melt in the furnace. There is found likewise in the gold mines a kind of led ore which they cal Elutia ; for that the water that they let into these mines (as I said before) washeth and carrieth down withall certain little blacke stones streaked and marked a little with a kind of white, and as heavy they be in hand as the very ore of gold ; and therefore gathered they be with the same ore, and laid in the paniers together therewith ; and afterward in the furnace when the fire hath made a separation between them and gold, so soone as they are melted do resolue into the substance of the white lead or tin glance aforesaid."

If Pliny's observation that this variety of *plumbum candidum* is as heavy as gold could be relied upon, the view would be plausible that he was cognizant of platinum, but unfortunately in other places he gives evidence of great inaccuracy in this respect. So too there seems no good reason for considering the metallic *electrum* to be anything other than the natural or artificial white alloy of gold and silver. If there were any question as to whether platinum were known to the ancients, it would seem to be completely answered in the negative by the fact that no platinum object, no nugget, or grain of platinum has been found among ancient remains.

Soon after the introduction of platinum into Europe, no inconsiderable amount of work was done upon it, by Watson, Scheffer, Lewis, Macquer, Marggraf, Bergman, Guyton de Morveau, and others. A few chemists, led by Buffon,* cast doubts upon its elementary character. Buffon when reading his history of minerals to the Dijon Academy held that platinum was an alloy of gold and iron, because it was attracted by a magnet, and, said he, if platinum be a metal there must be a second substance in nature attracted by a magnet. Von Milly believed that mercury was also present in the alloy, but Blondeau,* professor of mathematics at Brest, showed the great improbability that platinum was anything other than a simple metal.

* *Obs. sur. phys.* (Rozier), 3, 322 (1774).

The first suggestion of a practical use for platinum seems to have come from Lavoisier's † observation of its value for laboratory utensils. Many efforts were made in the last decade of the eighteenth century to fuse platinum or to get it into workable form. The first recorded success in this direction was that of Janetty,‡ a Parisian artisan who melted platinum by alloying it with arsenic. It was also alloyed with lead or with bismuth and then cupelled. Before 1800 l'abbé Rochon § wrapped grains of platinum in platinum foil, heated to redness and then hammered into an ingot. Moussin-Poushkin ‖ amalgamated platinum sponge with mercury and ignited in a muffle. Another process is described,¶ of wrapping ammonium chloroplatinate in platinum foil, igniting, and hammering. In 1800 Knight** published his process which with some modifications was generally adopted and remained in use till the metal was fused in the flame of an oxyhydrogen blowpipe by Deville and Debray, more than half a century later. Knight's process consisted in heating platinum sponge in a nearly cylindrical but slightly tapering clay mould, and compressing it by

* *Ibid.*, 4, 154 (1774).

† *Annales de chim.*, 5, 137 (1790).

‡ *Chem. Ann.* (Crell), 1790, ii, 53. The name is also spelled Jeanty, Jeannety, and Jannety.

§ *Ann. der Phys.* (Gilbert), 4, 282 (1100).

‖ *Chem. Ann.* (Crell), 1799, ii, 359.

¶ *Phil. Mag.*, 21, 175 (1805).

** *Ibid.*, 6, (1800).

a few hammer blows while in the furnace. This gave a coherent platinum which could be readily worked into an ingot. It was just about the opening of the century that the discovery of platinum in the Ural Mountains occurred,* and the supply being thus very materially augmented, the use of platinum in the laboratory became established. At the same time the study of the metal from a chemical standpoint led to the discovery of several other metals in the platinum ores. No less than five of the distinguished chemists of that day were working on the ore, with the special aim of separating out other metals which they had reason to believe were present. Palladium was first obtained by Wollaston; Collet Descotils was the *first to publish* indications of what we now know to be iridium, and Fourcroy and Vauquelin at the same time had this metal in hand in an impure form. The real discoverer of iridium should be recognized in Smithson Tennant, who not only separated it in purity, but also at almost the same time found in the same residues the element osmium which seems to have been wholly overlooked by the French chemist. This chapter was closed a few months later by Wollaston's discovery of rhodium.

The episode of the discovery of palladium throws a curious light upon the chemistry and chemists of that period. On May 12, 1803, Chenivix read a paper before the Royal Society † stating that two weeks previously (April 29th) he learned by a printed notice that a substance announced as palladium, a new metal, was offered for sale at the establishment of a well-known mineralogist. The printed notice * opens: "Palladium, or new silver, has these properties among others which show it to be a new noble metal" and then follows the enumeration of eight characteristics of the metal, closing with the address where the new metal could be bought. Chenivix goes on to say that the mode adopted to make known a discovery of so much importance without the name of any creditable person, except the vendor, appeared to him unusual and not calculated to inspire confidence. Having examined a small sample, Chenivix returned and purchased the whole supply. He then says: "We shall cease to wonder at what has been related by these chemists (Berthollet on affinity and Hatchett on alloys), when we learn that palladium is not as was shamefully announced a new simple metal, but an alloy of platina; and that the substance which can thus mask the most characteristic properties of that metal, while it loses the greater number of its own is mercury. Chenivix however on May 4th had written † to Vauquelin that palladium really was a new metal and Chenivix sent him a small specimen. A few days later another letter ‡ makes the claim that palladium is a platinum-mercury alloy. The editors of the *Annales* comment upon this that from Vauquelin's experiments Chenivix is probably wrong. It is interesting to read the comments of Chenivix upon the masking of the individual properties of both platinum and mercury in palladium §, a correct moral drawn from

*Osann says (*Ann. der Phys.* (Pogg.) 11, 311 (1827)) that the first mention he can find of platinum in connection with the Ural Mountains is *Ann. de Chim.*, 60, 317 (1806), where Vauquelin speaks of a rumor that platinum has been discovered in Siberia. Osann could not trace the origin of this rumor.

† *Phil. Trans.*, 93, 290 (1803).

* *Ann. Chim.*, 46, 333 (1803).

† *Ann. de Chim.* 46, 333 (1803).

‡ *Ibid.*, p. 336.

§ "The substance which has been treated of in this paper, must convince us how dangerous it is to form a theory before we are provided with a sufficient number of facts, or to substitute the results of a few observations for the general laws of nature. If a theory is sometimes useful, as a standard to which we may refer our knowledge, it is at other times prejudicial, by creating an attachment in our minds to a false premise. There was something almost prophetic in the observations of Chenivix, for there are in chemistry no elements whose properties exhibit such great variability when not pure, as do those of the platinum group.

The still anonymous discoverer of palladium immediately offered through Nicholson's Journal a reward of twenty pounds sterling to any one who should manufacture even twenty grains of real palladium,* and many chemists entered into the discussion as to the elementary character of the metal. On June 24, 1804, three days after Tennant had made known the discovery of iridium and osmium, Wollaston read a paper before the Royal Society* acknowledging himself to be the discoverer of palladium. Wollaston had been engaged in an effort to obtain malleable platinum, and having precipitated his solution of the ore with iron, he found a part of this precipitate to be soluble in a mixture of hydrochloric acid with saltpeter, potassium chlorpalladate being formed. He at once concluded that palladium must be a simple metal, because there is 'no instance in chemistry of a distinctly crystallized salt containing more than two bases combined with one acid,' another correct conclusion drawn from a false premise. In his solution Wollaston found also indications of rose-colored soluble crystals which he attributed to another new metal, and to this he gave the name rhodium. This is the explanation of his curious method of making known his discovery of palladium: "On this and on other accounts I endeavor to reserve to myself a deliberate examination of these difficulties, which the subsequent discovery of a second new metal, that I have called rhodium, has since enabled me to explain, without being anticipated even by those foreign chemists whose attraction has been particularly directed to this pursuit."† It is possible from this that Wollaston himself had been led to his work in part at least by the earlier observations of the French chemists.‡

preconceived ideas, which have been admitted without inquiring whether from truth or from convenience. We can easily correct our judgment as to facts and the evidence of experiment is equally convincing to all persons. But theories, not admitting of mathematical demonstration, and being but the interpretation of a series of facts, are the creatures of opinion, and are governed by the various impressions made upon every individual. Nature laughs at our speculations; and though from time to time we receive such warnings as should awaken us to a due sense of our limited knowledge, we are presented with an ample compensation, in the extension of our views, and a nearer approach to the immutable truth." *Phil. Trans.* 93, 317 (1803).

* "Dec. 19, 1803. Editor Nicholson's Journal. Sir: As I see it said in one of your Journals that the new metal I have called palladium is not a new noble metal as I have said it is, but an imposition and a compound of platina and quicksilver, I hope you will do me the justice in your next and tell your readers I promise a reward of £20, now in Mrs. Foster's hands, to any one that will make only 20 grains of real palladium, before any three gentlemen chemists you please to name, yourself one if you like. That he may have plenty of his ingredients, let him use 20 times as much quicksilver, 20 times as much platina, and in short of anything else he pleases to use; neither he nor I can make a single grain. Pray be careful in trying what it is he makes, for the mistake must happen by not trying it rightly. My reason for not saying where it was found was that I might make some advantage of it as I have a right to do. * * * I hope a little bit of whatever is made may be left with Mrs. Foster." Nich. J. 7, 75, 159 (1804).

* *Phil. Trans.*, 94, 419 (1804).

† Nicholson's J., 10, 204 (1805).

‡ Since this address was in type, I have received the interesting Presidential Address of Dr. Thorpe to the Chemical Society (London), in which this episode is treated quite exhaustively. What Wollaston's motive was in bringing his discovery to the notice of the scientific world in so extraordinary a manner, Dr. Thorpe says can only be surmised. Is not however, in view of Wollaston's statement, the motive clearly apparent? He had found palladium; he was in pursuit of rhodium; he knew that at least four other distinguished chemists were also on track of new metals in platinum residues, and any hint such as the publication of his work on palladium

It was in 1803 that Collet-Descotils had read a paper before the Institute of France on the cause of the different colors which affect certain salts of platinum. The residue from the solution of platinum ores in aqua regia and which was thought to be graphite, was still slightly soluble in aqua regia and gave a reddish tint to the potassium chlorplatinate made from it. The metal derived from this red salt was found to be only partially soluble in aqua regia and hence beyond question Descotils had in hand on several occasions a fairly pure iridium, containing, however, in addition to platinum perhaps traces of rhodium. He was convinced that he had here a new metal but he did not investigate its properties.*

The same day that Descotils spoke before the Institute, a second paper on the same subject was presented by Fourcroy and Vauquelin. After extracting the platinum from the ore by aqua regia, they fused the residue with potash and then treated it with acid. These chemists noticed that the potash was colored orange-yellow, but ascribed it to the presence of chromium. They thus missed the discovery of ruthenium, which was to be separated several decades later by Claus. They noticed also on one occasion that the black powder which consisted of iridium and allied metals, was apparently volatile, not recognizing osmium, the cause of the phenomenon. In their second memoir they had iridium fairly pure, and they too noticed the rose color of the double salt, but did not investigate the cause, which is the presence of rhodium.

would help them to anticipate him in the matter of rhodium, while if he kept silence, some of them could not fail to discover palladium.

*Of this Descotils writes (*Ann. de Chim.* 48, 165 1803): On peut déjà conclure que la coloration en rouge des sels de platine est due à l'oxigénation d'une substance qui diffère du platine, et qui présente, lorsqu'elle est a l'état metallique, une grande résistance à l'action des acides.

It was reserved for Tennant the following year to describe clearly the separation of iridium and osmium from the platinum residues, and to name the one from the many different colors through which its chlorids pass, and the other from the intolerable odor of its tetroxid OsO_4.

This osmium contained ruthenium but this was overlooked by Tennant, as it had been by Fourcroy and Vauquelin. A few years later Vauquelin* notes that osmium solutions give a beautiful blue color when reduced by zinc, this being a characteristic reaction, not of osmium but of ruthenium. At a still later date Berzelius noticed the orange color of the fusion of ruthenium with potash and saltpeter, but he attributed it to iridium.

It was in 1828 that the next effort was made to add to the number of the platinum metals. Professor Osann, of the University of Dorpat, announced† the discovery of a new metal in the platinum residues. He obtained long reddish prisms, with high luster, which were easily volatile and which Berzelius pronounced to be new. He had only 0.3 gram, and never obtained any more. The metal in these crystals he named *ruthenium*. They may have been an impure mixture of the tetroxids of ruthenium and osmium. In the next volume of the Annalen‡ he transfers the name ruthenium to another new metal with a golden luster, and at the same time he mentions two other metals, *pluran*, named from pl (atina) and ur (al), which is not further described, and *polin* (πολίος, gray), a gray metal of whose independent existence he seems to have some doubt. Polin was impure iridium with perhaps some ruthenium; pluran was quite possibly a mixture containing some ruthenium; the following year§

* *Ann. de Chim.*, 89, 241 (1814).

† *Ann. der phys.* (Pogg.), 13, 287 (1828).

‡ *Ann. der phys.* (Pogg.), 14, 340 (1828).

§ *Ibid.*, 15, 158 (1829).

Osann acknowledged the metal to which the name ruthenium had been given to be a mixture of the oxids of titanium, zirconium, and silicon.

Fifteen years pass and there appears at the University of Kazan, almost on the far eastern frontier of Russia, a chemist, Claus, who is destined to make greater contributions to the chemistry of the platinum metals, not only than those who had preceded him, but than any one of those who have lived in the nearly forty years since his death. Claus was fortunate in having at his disposal an almost unlimited quantity of platinum residues, from the stock which had accumulated at St. Petersburg during the period of the coinage of platinum. In spite of no inconsiderable effort, I have failed to verify the tradition that the great mass of these residues was sunk in the Neva, to prevent their use in debasing the coinage, and I am inclined to think that the greater portion was distributed to chemists, of which Claus received by far the largest share. In his first publication,* Claus announces the discovery of a new metal, which he calls ruthenium, for the purpose of honoring Osann, whose ruthenium had failed to prove itself an element. It may be mentioned that Osann hardly appreciated the compliment, for he attacked Claus with considerable asperity, accusing him of claiming to discover what Osann himself had discovered. To an impartial critic Osann wholly fails to make out his case. For nearly twenty years Claus continued his work, and his greatest service was in definitely settling the position of the six platinum metals among the elements.† He was the first who clearly showed that these six metals belong in a group by themselves. Up to this time many had held that platinum belonged with gold, palladium with silver, and ruthenium with tin.* He then arranges the elements in three pairs and in two series† as we find them in every table to-day. He also speaks of ruthenium and osmium being especially close to iron, an analogy hardly acknowledged even after the periodic tables of different chemists had appeared. He adds that while platinum is not in the group with gold, it is closely related to it.

Since the time of Claus no new metals have been found in platinum ore or belonging to the platinum group, which have been generally acknowledged as elements. Several chemists have, however, found what they have believed to be new elements, but the quantity has generally been so small that its verification has been impossible. In 1852 Genth‡ found two grains of a white metal in platinum from California gold. Its properties were unlike those of any known element.

In 1862 Dr. C. F. Chandler§ described a new metal in native platinum from Rogue River, Oregon; this possessed properties very similar to those described by Genth, and Chandler concludes that his metal is probably identical with that found by Genth.

In 1869 Guyard discovered a metal in Russian platinum which he described ten years later,|| and called ouralium. It resembles platinum but is softer and has an

* *Bull. Akad. St. Petersb.* 3 (1845), 38.

† *Ibid.* [2] 2 (1860) 160.

* Loc. cit. "Es is nicht zu leugnen, das in Beziehung einiger weniger Eigenschaften sich solche Analogien aufstellen lassen, allein ich habe Grund diesen nur einen geringen Werth beizumessen, und schliesse mich daher entschieden dem ersten Theile der Anschauungsweise der Verfasser an, indem ich, wie ich mich auch bisher ausgesprochen habe, die Platinmetalle alle für Glieder einer untrennbaren, wohlbegründeten Metallgruppe halte."

†

+ end of the horizontal series.	Principal Series	Os	Ir.	Pt.	Vert'cl Series.	— end of the horizontal series
	Secondary Series.	Ru.	Rh.	Pd.		

‡ *Proc. Acad. Sci. Phil.* 6 (1852), 209; *Amer. J. Sci.* [2], 15 (1853), 446.

§ *Am. J. Sci.* [2], 32 (1862), 351.

|| *Monit. Scient.* [3], 9 (1879), 795.

atomic weight of 187.5. Its chief difference from platinum is that when fused with potassium cyanide, the melt is orange. This work of Guyard's has never been confirmed.

In 1877 Sergius Kern* announced the discovery of a new metal in platinum residues with atomic weight of 154, to which he gave the name of davyum. This has not only not been confirmed but recently Mallet† has gone over the whole ground with great care, and has shown that in all probability Kern's davyum is a mixture of iridium with rhodium and a little iron. Mallet obtained a residue in much the same way as Kern with similar properties and atomic weight, but proved it to be a mixture. This is the more significant since 154 would be the anticipated atomic weight of a metal lying between the lighter and heavier metals of the group.

The great influence of one of the metals of this group upon the properties of another, even if present in but small quantities, has already been alluded to. It has been long known and a very considerable series of experiments on this point is described by Claus.‡ Nevertheless it remains true that a good proportion of the workers on these metals have, for a time, at least, supposed themselves discoverers of new elements. We may say, however, that not yet is there any reliable evidence of any new metal between the two series, that is, with an atomic weight of about 150; nor has there been any trace of *eka-manganese*, with its atomic weight of 100, and which some chemists would expect to find resembling the platinum metals in its properties.

It is by no means impossible that new metals may be discovered in this group, but the fact that in more than half a century, no confirmed discovery of such has taken place, and that had it not been for a misinterpretation of reactions by which ruthenium was overlooked, we might say that it lacked but three years of a century since a new metal has been discovered, is not calculated to give us much encouragement. There does, indeed, seem, according to the periodic table, to be a place for three metals of atomic weight near 150, but it hardly seems probable that such occur in any of the known platinum ores which have been so thoroughly investigated, unless it be in extremely minute quantity. There is, however, always the possibility of the discovery of new platinum ores, differing in character from those now known, which, whether from the Ourals, or Colombia, or from the Pacific coast, are approximately the same in composition.

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(*To be concluded.*)

* *Chem. News*, 36 (1877), 4, 92, 114, 155, 164; 37 (1878), 65.

† *Am. Chem. J.*, 20 (1898), 776.

‡ C. Claus; Beiträge zur Chemie der Platinmetalle, Dorpat, 1854, chap. iv. Modificationen, welche die ursprünglichen Reactionen der einzelnen platinmetalle durch Beimengungen der übrigen Metalle aus dieser Gruppe erfahren, p. 42.

THE ROYAL SOCIETY OF CANADA.

The nineteenth meeting of the Royal Society of Canada was held in Ottawa, Canada, from May 28th to May 31st inclusive, in the Assembly Hall and rooms of the Provincial Normal School. Besides fellows of the Society from various provinces there were delegates from affiliated societies in all parts of the Dominion of Canada who reported as to the work done by them. Rev. Professor Clark, the able principal of Trinity University, Toronto, delivered the annual address 'On the Work of the Royal Society.' Numerous papers bearing upon history, science and belles-lettres were read.

Dr. L. O. Howard, the eminent economic entomologist from Washington, delivered a most practical and admirably illustrated lecture, on the evening of May 31st, His

Excellency, the Governor-General of Canada, Lord Minto, presiding. A deputation of fellows of the Royal Society waited upon Premier Sir Wilfred Laurier, and members of his cabinet urging upon them the necessity of erecting a national museum building in which to house, safely and well, the immense collections which have been acquired by the Geological and Natural History Survey of Canada since 1842. This deputation consisted of Rev. Professor Clark, Dr. G. M. Dawson, Sir Sandford Fleming, Sir James Grant, President Loudon, Monseigneur Laflamme (rector of Laval University, Quebec), Hon. Joseph Royal, Dr. L. H. Fréchette, Hon. Premier Marchand, Dr. George Stewart, Proessor John Cox, of McGill University, and the member of Parliament for Ottawa, Dr. N. A. Belcourt. The deputation was well received and a definite promise made that an item would be placed in the supplementary estimates for the coming year toward the erection of a National Museum.

Amongst the scientific papers which no doubt prove of more interest to the readers of SCIENCE than the historical or purely literary of the French and English Sections, the following are noted:

MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES.

On the Depression of the Freezing-Point by Solutions Containing Sulphuric and Hydrochloric Acids: By JAMES BARNES, M.A., Dalhousie College, Halifax, N. S. Communicated by Professor J. G. MacGregor.

The object of this paper is to find out whether or not the depression of the freezing-point by solutions containing (1) sulphuric acid, and (2) sulphuric and hydrochloric acids, is calculable by the aid of the dissociation theory and of electrically determined ionization coefficients, and if so on what assumption as to the mode of ionization of the sulphuric acid. Kryoscopic observations on these solutions are of interest because sulphuric acid is usually supposed to divide into H and HSO_4 as ions in somewhat strong solutions and into 2H and SO_4 in extremely dilute solutions, the change from the one to the other mode of ionization occurring gradually as dilution is increased. The possibility of predicting the depression, therefore, forms a test not only of the general applicability of the dissociation theory, but also of the electrical method of determining the ionization coefficients and of the current view of the mode of ionization of sulphuric acid. A modification of Loomis's method has been used for the determination of the freezing-points, and Kohlrausch's method for the determination of conductivities.

On the Relative Bulk of Weak Aqueous Solutions of Certain Sulphates and their Constituent Water: By CHARLES M. PASEA, B.Sc., Dalhousie College, Halifax, N. S. Communicated by Professor J. G. MacGregor.

Dilute solutions of several of the sulphates have been found to possess a smaller volume than the water which they contain when in the free state. The object of this paper is to determine whether or not this is so in the case of solutions of the sulphates of sodium, manganese, cadmium and iron. The requisite observations of density were made with an Ostwald-Sprengel Pycnometer, with an accuracy of about 1/200 per cent. which in most cases was found to be sufficient for the purpose in hand.

A Universal Electrical Measuring Apparatus: By W. LASH MILLER, B.A., Ph.D., and F. B. KENRICK, B.A., Ph.D.

Mathematical Notes: By J. H. McDONALD, B.A., University of Toronto. Communicated by Professor Baker, Ph.D.

The paper is divided into three parts, and deals with the development of theorems on the following subjects: (1) Special biquadratic involutions and the transformation of elliptic integrals. (2) The representation of a number as the sum of two squares. (3) The twisted biquadratic curve of the first species.

Electrical Screening in Vacuum Tubes: By J. C. McLennan, B.A., Demonstrator in Physics, University of Toronto. Communicated by President Loudon.

The paper deals with a changing effect observed by Professor J. J. Thomson in connection with his experiments on Faraday cylinders inserted in vacuum tubes. The effect referred to is traced to electric conduction along the surface of the glass walls of the tube. Insulators such as sealing wax are shown to be quite unreliable in electrometric work without inner tubes, when voltages such as those produced by an induction coil are used. The importance of good earth connections is developed and Faraday cylinders inserted in vacuum tubes are shown to act as perfect electrical screens unless made of metal thin enough to permit cathode rays to pass through.

Canadian Experiments with Nitragin for promoting the Growth of Legumes: By Frank T. Shutt, M.A., F.I.C., F.C.S., and A. T. Charron, B.A.

By means of diagrams and photographs Mr. Shutt indicated the striking results recently obtained at the Central Experimental Farm or Station at Ottawa in soil-inoculation. The paper when published will be copiously illustrated. Fellows of Section IV. attended the meeting in Section III. during the reading of this important paper.

An Apparatus for the Determination of the Melting Point of Fats: By Frank T. Shutt, M.A., F.I.C., F.C.S., and H. W. Charlton, B.A., Sc.

On Soil Temperature: A continuation of papers presented at preceding meetings. By Prof. C. H. McLeod, M.E.

GEOLOGICAL AND BIOLOGICAL SCIENCES.

The Nepheline Rocks of Ice River, B. C: By A. E. Barlow, M.A., D.Sc. Communicated by Dr. G. M. Dawson.

Among the rock specimens collected by Dr. G. M. Dawson, in 1884, are some which seem to possess many points of rather unusual interest at the present time, illustrative for the most part of the phenomenon of magmatic differentiation, with which of late we have become more familiar through the labors of Vogt, Brögger and others. The specimens in question were obtained from exposures along and in the vicinity of Ice River, a branch of the Beaverfoot River in British Columbia, about eight miles southeast of Leanchoil and Ottertail stations on the Canadian Pacific Railway. The hand specimens, which were made the subjects of examination, were of necessity rather hurriedly collected and were chosen mainly as representing the various phases of this igneous complex. It is therefore a very agreeable surprise to find that the material thus selected at a time when magmatic differentiation was but little understood, should illustrate a passage so complete that no appreciable gap occurs unrepresented by specimens from the most basic Ijolite containing 36.988 per cent. of silica to ordinary nepheline and sodalite syenite containing 53.638 per cent. of silica.

Notes on North American Species of Dadoxylon: By Professor D. P. Penhallow, of McGill University.

The author brings under review a large amount of material collected by the late Sir William Dawson, representing various species of the genus *Dadoxylon*, and he also describes new species of allied plants from the Cretaceous and Permian of Kansas from the collections of Professor C. S. Prosser. The plants formerly included under the name of *Dadoxylon*, are now to be regarded as falling into the three principal groups, of which the first, extending through Paleozoic time, properly belong to the genus *Cordaites*, which is now fairly well known through its fruit, flowers, leaves and stem structure. The second group embraces plants of the same general Araucarian type, but ranging through the more recent formations commencing with the Jurassic. The third group is reserved under the old name of *Dadoxylon*, for all those plants which cannot be readily assigned to a given and well recognized genus, and from which they may be transferred as occasion requires.

The present revision eliminates many of the errors of the earlier descriptions, and draws attention to important characters hitherto overlooked.

Quarry and Workshop of the Stone Age in New Brunswick: By G. F. MATTHEW, A.M., LL.D.

The author describes a locality on the St. John River in New Brunswick, which appears to be the source of certain carnelian weapons and implements that have been found at various points on the River St. John. The locality is at Washadunoak Lake, in Queen's County.

Notes on the Physical Feature and Geology of the Area between the Lower Ottawa and the St. Lawrence Rivers: By R.W. ELLS, LL.D.

This paper discusses some of the points relating to denudation which have been furnished by a series of borings recently made in the area south of the Ottawa River. From these the presence of a preglacial channel of that river of considerable depth is clearly shown following in part the lines of the Canada Atlantic and the Canadian Pacific railways. The thickness of the several formations of the Palæozoic formations in this part of the basin is also considered, and the presence of several important faults and anticlinals which traverse the district is considered, and their probable location given. These features are of interest at the present time in view of the inquiries recently made as to the possible occurrence of natural gas and oil in certain portions of this basin.

The Palæozoic Formations of Eastern Canada: By HENRY M. AMI, M.A., D.Sc., F.G.S., of the Geological Survey of Canada. Communicated by Dr. Fletcher.

Considerable discussion has arisen of late regarding the place which many of the geological formations of Eastern Canada occupy in the column of the Palæozoic period. There is much confusion in the variety and use of many geological, geographical and other terms in describing or defining various formations in this portion of Canada.

An attempt is made to present a simple and at the same time comprehensive classification of the various strata which compose the earth's crust and belong to the Palæozoic period. Many interesting questions in the nomenclature of Canadian rock formations are discussed and such names introduced as will serve to designate many hitherto unrecognized or undifferentiated formations in Canada.

Some Recent Work in Economic Entomology. Presidential Address of Section: By the REV. DR. BETHUNE.

In his presidential address Dr. Bethune presented a most comprehensive and practical treatise giving historical references and data bearing upon researches in economic entomology in Canada. From the days of small beginnings to the present specific legislation, restricting the encroaches and ravages of insect pests, as well as encouraging the application of every scientific fact of value to man in the department of agricultural pursuits, the author points out what has been, and what is, being done.

Sponges from the Coasts of North-Eastern Canada and Greenland: By LAWRENCE M. LAMBE, F.G.S. Communicated by Dr. Whiteaves.

The present communication forms the fifth of a series of papers, four of which have already appeared in the transactions of this Society, three of these are upon the recent marine sponges of the Pacific and one on those of the Atlantic or eastern coast of Canada, mainly from the Gulf of St. Lawrence and the coast of Nova Scotia. The paper now submitted is supplementary to the one last mentioned and treats of the more northern forms. It is based upon a collection received from Professor D'Arcy Thompson of University College, Dundee, Scotland. The Monaxonida, Tetractinellida, and Calcarea are represented by twenty species, half of which are described as new. Six octavo plates of drawings illustrate the descriptions and show the spicules and their position in the skeleton as well as the general form of the sponges.

The Cerebral Neurons in relation to Memory and Electricity: By Sir James Grant, K.C.M.G., M.D.

The brain neurons and cells, like the cells in other tissues of the body, as years pass on, give evidence of lessening power and activity. The line of present investigation demonstrates that the electrical current through the brain rotates its molecules to such a degree as to produce a most noticeable physiological response, in the direction of improved memory.

Un éboulement à St. Thuribe-de-Vincennes, comté de Champlain: Par Mgr. J. C. Laflamme.

Modifications remarquables causées dans le régime de la rivière Ste-Anne par l'éboulement de St-Alban: Par Mgr. J. C. Laflamme.

These two papers by the Rector of Laval University, Quebec, deal with important geological phenomena affecting the Pleistocene or later Quaternary boulder clays, marine clays, sands and gravels of the north shore of the St. Lawrence. There the streams which flow into this river are now cutting into these newer and uncemented rock-materials in order to form a river bed, and what appears to be a period of unstable equilibrium has set in, leading to many disastrous landslides and landslips in which many human lives have been lost, not to speak of destruction of other life and property.

The Honorary Secretary's Annual Report dealt with the progress of research in the various sections throughout Canada. The preservation of the site of Louisbourg, Nova Scotia, the proposed National Museum, the death and loss to science and the Society of its first president, Sir William Dawson, the proper equipment of a Hydrographic Survey for Canada, tidal observations and other historical as well as literary results were referred to in an able and eminently practical manner.

The following is a list of the officers of the society elected for the ensuing year: *President*, Dr. Louis Honoré Fréchette, C.M.G.; *Vice-President*, President Loudon of Toronto University; *Honorary Secretary*, Sir John G. Bourinot; *Honorary Treasurer*, Dr. James Fletcher.

In the Geological and Biological Section the following officers were elected: *Chairman*, Dr. A. H. Mackay, Halifax, Nova Scotia; *Vice-Chairman*, Professor F. D. Adams, McGill University, Montreal; *Secretary*, Professor G. U. Hay, St. John, New Brunswick.

In the Physical and Mathematical Science Section, the following were chosen: *Chairman*, President Loudon; *Vice-Chairman*, Dr. R. F. Ruttan; *Secretary*, E. Deville, Surveyor-general of Canada, Ottawa.

H. M. Ami.

SCIENTIFIC BOOKS.

The Logical Bases of Education. By J. Welton, M.A. London, Macmillan & Co. 1899. Pages xvi + 288.

This book is one of a series, 'Macmillan's Manuals for Teachers,' edited by Oscar Browning, M.A., Principal of the Cambridge University Day Training College, and S. S. F. Fletcher, B.A., Ph.D., Master of Method in the same institution. Although the book is written especially for teachers, it is not a book on education, save indirectly and incidentally. Only one chapter deals directly with Education, and elsewhere throughout the book, even the word education is rarely used.

But it should be said at once that the book is none the worse for that. There are many books —books on psychology, ethics, hygiene, for example—which do not deal specifically with education, yet no teacher can afford to dispense with a serious study of the subjects of which they treat. Mr. Welton's 'Logical Bases of Education' is such a book. At the same time, the title is somewhat misleading. The reader who expects to find here a logical, *i. e.*, a well-reasoned discussion of the fundamental principles of education—of the scope and meaning of the education of children and youth for individual development and for social service—will be disappointed. So also will the reader who expects to find an exposition of the application of logic to the processes of education, in detail—to teaching and governing.

It is only fair to say that the author had no intention of meeting such expectations. His purpose is stated in the first paragraph of his preface: "The aim of this book is to set forth the rational bases of all true educational work. It is believed that such bases can only be found in those modern developments of logical theory which have marked the latter half of this century." In accordance with this purpose, Mr. Welton's book is an elementary treatise on epistemology and logic. It consists of chapters on the 'General Nature of Knowledge'; 'Postulates of Knowledge'; 'Knowledge and Language'; 'Knowledge and Logic'; 'Nature of Judgment'; 'Types of Judgment'; 'Formal Relations of Propositions'; 'The Method of Knowledge'; 'Deductive Inference, Syllogism, Construction'; 'Outline of Inductive Method'; 'Observation'; 'Testimony'; 'Hypotheses'; 'Direct Development of Hypotheses'; 'Indirect Verification of Hypotheses'; 'Definition, Classification and Explanation'; 'Logic and Education.' And these chapters are followed by fourteen pages of 'Exercises in Inference'. There is also a serviceable index.

The author's discussion of the topics enumerated is clear and interesting. His only claim to originality consists in the form in which the materials are presented. The sources on which he has drawn for inspiration and guidance, and even for much of his subject-matter—for quotations abound—are referred to in footnotes, and these footnotes are very numerous. At the same time it is clear that he has an independent command of his subject; and he has generally chosen his authorities well.

When Mr. Welton comes to discuss specifically, in the last chapter, the bearing of logic on education, we find him, very properly, cautioning the teacher against expecting to derive detailed rules of procedure from logic any more than from psychology. "Both sciences give general guidance only. Psychology investigates the forms of actual mental activity common amongst men and children, and, therefore, a study of psychology aids the educator by suggesting to him the best ways of awakening such activity. Logic, on the other hand, is regulative, and helps the educator to determine the general lines on which such activity should proceed to attain the goal of knowledge. . . . But the subject matter of the thought and the consequent character of the knowledge gained by the pupils can be determined neither by psychology nor by logic. . . . Logic warns us to insist on sufficient evidence; but logic alone cannot decide when the evidence is sufficient."

So much, in brief, for logic. "The function of education," Mr. Welton tells us, "is to lead the child to find his true place and his true work in the universe." Without stopping to comment on the adequacy or inadequacy of this definition of the function of education, or on its full meaning, as stated, particularly on the phrases 'true place' and 'true work,' we may assume that the definition is intended to cover an education broad enough and deep enough to meet the needs of individuals, both as individuals and as members of a democratic society.

To fulfill this function education must enable every one to understand 'the universe,' at least to some extent; and further, "the universe which a child must learn to understand is a social and a moral universe as well as a physical one; the facts of experience with which he starts are found in his relations to his fellows as well as in those of the material world. In these facts, too, he must find laws, and through laws he must pass to the conception of that moral system, in which alone he can find the true freedom of rational and self-realizing activity.''

Having set forth his view of the function of logic and of education, Mr. Welton is prepared to discuss their relation to each other. The points which logic emphasizes in educational theory, he says, are (1) 'that all true education must be relative to the society in which it is given'; and (2) 'that logic equally with psychology, teaches the educator that the attainment of knowledge is the result of mental exertion.'

That these are fundamental principles of a rational educational theory, every one will admit. Both deserve strong emphasis; and at the present stage of the development of educational theory, particularly the first. I say particularly the first, because the second has been emphasized from time immemorial, while the first has only recently come to receive the attention it deserves at the hands of writers and speakers on education. Education is primarily a social study, like economics, or government. The development of the individual is fruitless unless it proceeds with constant reference to his membership in the contemporary social organism; and the maintenance, organization, and direction of education constitute one of the most important functions of society.

Both of these points are discussed briefly by Mr. Welton. One finds himself regretting that so little space is devoted to the discussion of these important topics; and the value of the book consists, not in a fresh contribution to educational theory, nor in a discussion of the relation of logic to educational theory; but in the general intellectual stimulus such a book must give to every earnest teacher.

The teacher may learn from this book what knowledge is, and how knowledge is tested and assimilated. But he will not find in it an enumeration of the kinds of knowledge to be sought, nor a discussion of the relative efficacy of different kinds of knowledge in promoting individual and social well being. He will get from it no teaching devices, but he may expect to derive from it valuable assistance toward gradually developing within himself the right professional attitude throughout the whole range of his activity.

PAUL H. HANUS.

HARVARD UNIVERSITY.

The Theory and Practice of Interpolation, including Mechanical Quadrature and other Important Problems concerned with the Tabular Values of Functions, with the requisite tables. By HERBERT S. RICE, M.S., Assistant in the Office of the American Ephermis, and Professor of Astronomy in the Corcoran Scientific School, Washington, D. C. Lynn, Mass., The Nichols Press. 1899.

Perhaps the first impression which this book produces is one of surprise that the author has found enough material relating to interpolation to fill 234 pages of small quarto. A brief inspection, however, shows that we have to do with a work dealing with most if not all of the important problems which arise in connection with the formation and use of the numerical tables which play so conspicuous a part in applied mathematics. In short, we find here a development not only of the familiar processes of interpolation, but those of numerical differentiation and integration, with a variety of applications to astronomical and other problems.

The author's preface informs us that he has attempted no marked originality, either in subject matter or method. "Indeed, sufficient has hitherto been written of interpolation, quadratures, etc., to firmly dissuade one from such an endeavor." * * * "But while viewing the matter in this practical sense, the writer regards his work as no mere compilation."

In the development of the subject the derivation and discussion of the important formulæ of Newton, Stirling and Bessel naturally constitute the basis of the structure. As this work progresses we have each important step illustrated by a number of numerical examples, together with the development of such precepts as are important in the practical application. For instance, in the great majority of cases we have to do with numerical quantities which, like the familiar logarithmic and trigonometrical tables, can only be regarded as approximations to the truth. In arranging the computation of such a series of values it becomes a very practical matter so to select the intervals as to avoid unnecessary labor on the one hand and the possible introduction of inadmissible errors in the interpolated values on the other. We have here the practical rule evolved showing that this may ordinarily be accomplished by choosing our intervals such that differences beyond the fifth order may be disregarded. Of course, in the very uncommon case of a rational integral function we may reach absolute accuracy by carrying our computation to the point where the differences vanish.

The subject of mechanical quadrature is doubtless more familiar to the mathematical astronomer than to any other class of readers. Owing to the convenience and facility with which it may often be applied to the evaluation of definite integrals it seems to deserve a more prominent place in works treating of applied mathematics than is commonly the case. Here we find the processes of both single and double integration very fully developed, based in turn on Newton, Stirling and Bessel's formulæ.

Every one naturally assigns a somewhat exalted position to his own special line of investigation. It is, therefore, perhaps not surprising to find, on page 79, what to some may appear to be a somewhat 'dark saying,' viz: "Interpolation has undoubtedly done more for mathematical science than any other discovery excepting that of logarithms." Not to mention the Arabic system of notation, why may we not with equal propriety make a like assertion in regard to multiplication?

Among the problems solved the following are suggestive:

To solve any numerical equation whatever involving but one unknown quantity.

Given a series of numerical functions embracing a maximum and minimum value. To find the value of the argument which corresponds to the maximum and minimum function.

An appendix deals with symbolical methods. Fifteen pages are given to tables, principally the coefficients in Newton, Stirling and Bessel's formulæ, while two pages devoted to the bibliography of the subject complete the work.

Naturally a treatise like this will interest only a limited class of readers, such as workers and students in astronomy and mathematical physics. To all these it can be cordially recommended.

C. L. DOOLITTLE.

FLOWER OBSERVATORY.

BOOKS RECEIVED.

Education in the United States. A Series of Monographs prepared for the United States exhibit at the Paris Exposition, 1900. Edited by NICHOLAS MURRAY BUTLER. Albany, N. Y., J. B. Lyon Company. 1900. In two volumes. Pp. xviii+977.

Department of Geology and Natural Resources of Indiana. 1899. W. S. BLATCHLEY. Indianapolis, Wm. B. Burford. 1900. Pp. 1078.

North America. RALPH S. TARR and FRANK M. MCMURRY. New York and London, The Macmillan Co. 1900. Pp. xix+469. 75 cts.

Familiar Fish, their Habits and Capture. EUGENE MCCARTHY, with an introduction by DAVID STARR JORDAN. New York City, D. Appleton & Co. 1900. Pp. xi+216. $1.50.

A Book of Whales. F. E. BEEDARD. New York, G. P. Putnam's Sons; London, John Murray. 1900. Pp. xv + 320.

Physiology for the Laboratory. BERTHA MILLARD BROWN. Boston, U. S. A., Ginn & Company. 1900. Pp. v + 167.

A Brief History of Mathematics. KARL FINK. Translated by W. W. BEMAN and D. E. SMITH. Chicago, Open Court Publishing Co. 1900. Pp. xii + 333. $1.50.

Exploitation technique des forêts. M. H. VANUTBERGH. Paris, Gauther-Villars. 1900. Pp. 176.

La garance et l'indigo. GEORGE F. JAUBERT. Paris, Gauthier-Villars. 1900. Pp. 166.

Lehrbuch der Photochromie. WILHELM ZENKER. New edition edited by B. SCHWALBE. Braunschweig, F. Vieweg und Sohn. 1900. Pp. xiii + 157.

Das soziale und sittliche Leben erklärt durch die seelische Entwicklung. J. MARK BALDWIN. Translated from the second English edition by DR. R. RUEDEMANN, with preface by DR. PAUL BARTH. Leipzig, J. A. Barth, 1900. Pp. xv + 466.

SCIENTIFIC JOURNALS AND ARTICLES.

THE *Journal of the Boston Society of Medical Sciences* for May is more exclusively technical than usual. Harold C. Ernst and W. H.

Robey, Jr., present some 'Studies in the Mechanism of Agglutination,' W. R. Brenckerhoff describes 'The Pathology of Azoturia,' and A. W. Balch notes 'A Possible Cause of Azoturia,' Allen Cleghorn discusses 'The Physiological Effects and the Nature of Extracts of Sympathetic Ganglia,' R. W. Lowett has a note on 'Movements of the Normal Spine in their Relation to Scoliosis,' and Harold C. Ernst treats of 'Actinomycosis of the Udder of the Cow.'

DISCUSSION AND CORRESPONDENCE.

THE MISUSE OF TECHNICAL TERMS.

When a layman discourses upon a professional subject, as when a cobbler expounds electricity, he may be excused for lack of familiarity with technicalities, and for a consequent misuse of technical terms, though one may question the propriety of his posing as an authority on the subject. The case is different with a professional man who has acquired the right to speak by reason of high position or meritorious work, or both. A misuse of terms in speaking to others of his own profession would probably not affect them seriously, as they would perceive the error and discern the truth that is behind it, or the mistake, if there be any, in the conclusions. But when he addresses an audience of laymen, it is incumbent upon him to be careful of his language, especially in scientific matters, since these are loaded down with technical terms of great exactness in meaning, the wrong use of which may result to the uninitiated in error as well as confusion. To be sure, the use of abtruse or uncommon terms where common words would convey the true meaning is tiresome pedantry in professor and layman alike, but whether the words are common or uncommon, let them be used correctly.

In these days of specialties and specialists a highly trained authority in one profession is a layman among the members of another, and to some degree is at their mercy as to technical terms; still more so are those who, without special training, but with intelligence enough to appreciate the ability of scholars, and with a corresponding interest in such features of the various professions as touch upon their life and experience, must depend upon what they can get from the utterances of professional men in quasi-scientific or semi-professional form, to satisfy their thirst for knowledge. They constitute the greater portion of the readers of scientific journals which are not strictly technical, and they want expressions in regard to science that are more authoritative than those appearing in the daily newspaper, where, for example, we read from time to time that a man has taken an electric *current* of an incredible number of volts. The diffusing and popularizing of science has introduced its nomenclature to a wide circle of such interested but imperfectly trained readers, and has made accuracy in the use of terms more important now than ever before. There is no need to go to excess in technicalities. Now and then we encounter papers or even extended treatises in which the author delights in coining words, after the manner of a Heine or a Richter, apparently expecting thereby to enrich our vocabulary, but while occasionally a term thus introduced stays, most commonly it falls out of use very speedily. That is something that takes care of itself. Our only contention is that a technical term should be used correctly, if at all, and that this is the more imperative if the term is not a rare one.

It is true that in some branches of science, possibly in all branches, there are theories or hypotheses, not yet well enough established, phenomena not well enough understood to make it possible to give to the terms the exact significance they may come to possess later. This was illustrated in the discussions that abounded four years ago, regarding the X-rays, and the proper words to designate the radiant agent and the pictures produced by it. In response to a request for a suitable name for the latter, no fewer than twenty were suggested to *The Electrical World*, with special reasons for each one. Of these twenty none has been generally adopted, and today the pictures may be called by any one of several names without violating propriety or precision. It is quite different, however, in regard to certain names in subjects that have passed a transition stage, and probably in none has the nomenclature been more fully developed or better established than in mechanics. In this science new words are proposed from time to time, but not to change or to substitute those already in use. There was a time when the word 'energy' (not the idea) was new; when force was confounded with work; when power was not generally so completely distinguished from both force and work as it now is. There was then justification for Grove to write of 'The Correlation and Conservation of Forces,' and for Helmholtz to discuss the 'Conservation of Force' (*Erhaltung der Kraft*). But from the somewhat turbid and confused use of terms fifty years ago, there crystallized out a clear and well-defined meaning to go with each one of several names, and these have become so well established that there is little excuse for misuse of them. Of these force, work, energy, and power are or should be among the most familiar, and a scientific writer who confounds one of them with another is as gravely at fault as a literary critic who confounds will and shall, or lie and lay.

It was a little surprising, therefore, not very long ago to read in a leading educational journal, an article by the physical director of a leading university, discussing such exercises as jumping, running, and the like, seriously comparing the *force* necessary to raise the performer six feet with that required to lift him one foot, and implying that the force increased with the height. Just when the laws of gravitation were so changed as to make a man heavier at two feet above the earth than at a height of one foot it would be interesting to learn. That the impulse needed to give him the requisite velocity to rise a definite height, might be acquired by means of *any* force in excess of his weight according to the time during which it is exerted was overlooked or at least not taken into account. In other portions of the article, also appeared misconceptions of the relations of force exerted, time of its action, work expended, and energy acquired, as witnessed by such expressions as 'number of foot pounds lifted,' 'every pound of energy,' etc. It would be ungracious to doubt that the author knew what he meant, but he used technical terms in mistaken senses.

Still more awry are the statements of a writer in a recent number of one of the best and most popular engineering magazines, in expatiating upon the power in a pound of coal. On their face these statements are striking, so much so as to be reprinted by newspapers culling the best extracts from the current literary and scientific magazines. Examined critically they are astonishing. The writer is at some pains in the beginning to explain the meaning of work and to point out that 'in all mechanical work we must consider the element of time,' and then follows with statements that ignore it, by contrasting the energy of the pound of coal with a man-power, or a horse-power. He recurs frequently to the idea 'that this pound of coal contains within it the power of 236 horses.' Its power might as well have been declared that of 472 horses, or of only 118 horses, or of any other number. 'It is interesting,' he continues, 'to follow this out in order to find how much of the power which nature has given us in this pound of coal we are able to get out of it.' Nature has given us not 236 horse-power in the pound of coal, but an indefinite power, and if we can get any work out of it the power is only limited by the rate at which the work can be obtained; for example, the number of foot-pounds per minute.

Apparently the reason in some of these instances for using the word power instead of energy is the idea that possibly the latter term may be less familiar to the reader than the former; but if both are to be used in a strictly technical sense, one is probably as generally understood as the other, and certainly if the author had taken as much pains to define energy in the beginning as he did to define power, he would have cleared the way for the use of the term in its proper sense instead of continually using the other word in a sense at variance with his own explanation. It is true that we do sometimes come upon the word power for force, as where the power and power arm, are compared with the resistance or the weight and its arm. The term *activity* has been introduced to get rid of the tendency to misuse the word power, but even if we admit the untechnical meaning of the word as it appears in the title of the article referred to, the moment it appears in the compound 'horse-power' it is inevitably technical in form and in meaning. As such it is not force, nor work, but rate of working.

One is not surprised at such confusion of meanings in the productions of men who appear from time to time with crude and hazy schemes for correcting or overthrowing all existing systems of science or philosophy, and who make professors weary by their importunities, but one does not look for it in an honored seat of learning. To find it there makes one wonder whether Helmholtz is unknown, or Maxwell has lived in vain.

Although mechanics as the oldest of sciences has been chosen for these illustrations it is likely that every other branch of science can show similar perversions. We have even known the 'parallels of longitude' to be referred to in all seriousness, but as that was not uttered by a scientific man it is rather to be smiled at than criticized.

D. W. HERING.

CORRECTION.

IN No. 277 of SCIENCE, I stated that the $MgCl_2$ solution used in my experiments on artificial parthenogenesis was a $20/8n$ solution. I have since found that the assistant who made the Mg-solution used and who has left the laboratory must have made a mistake as the solution contained only about 120 g. of $MgCl_2$ in a liter. This does not affect my results, but might be an obstacle to the successful repetition of my experiments by others.

JACQUES LOEB.

CHICAGO, June 8, 1900.

NOTES ON ELECTRICAL ENGINEERING.

SUBMARINE TELEPHONY.

IF waves were sent along a string stretched under water the effect of the water would be to *damp* the motion of the string causing the waves to become more and more attenuated as they travel along the string, and to *distort* the waves so that a wave initially complicated in shape would be smoothed and spread out more and more as it travels along the string.

Assuming the damping or frictional force of the water on the string at a point to be strictly proportional to the sidewise velocity of the string at that point, it can be shown that there is a certain relation between the tension of the string and its weight per unit length for which the attenuation of a wave is a minimum and for which a wave is not distorted as it travels along the string.

A submarine cable for telegraphy behaves in a manner entirely analogous to a string stretched through a viscous fluid as described above. Electrical impulses acting at one end of the cable produce electrical waves which travel along the conductor of the cable. The electrical resistance of the conductor is analogous to the frictional resistance of the water on the string, the self-inductance of the conductor is analogous to the weight of the string and the inductive capacity of the gutta-percha insulation is analogous to the tension on the string.

There is a certain relation between resistance of conductor, self-inductance of conductor, and inductive capacity of the gutta-percha covering for which electrical waves suffer minimum attenuation and no distortion as they travel along the cable. Oliver Heaviside first called attention to this condition for the *distortionless circuit*, as it is called and Dr. M. I. Pupin, in a paper read before the American Physical Society in December, showed that the distortionless condition can be realized practically by *distributed inductance* that is by connecting small coils of wire at intervals along a cable or land line.

The practical importance of the distortionless circuit is great inasmuch as such a circuit would greatly extend the possible speed of ocean telegraphy and perhaps even make ocean telephony possible.

The limit of speed of ocean telegraphy is set mainly by the distortion of the electrical impulses which pass along the cable. This distortion causes the impulses at the receiving end to overlap each other greatly.

The limitation of long distance telephony is set in part by the attenuation of the electrical waves and in part by the distortion of the waves. The first makes it difficult to produce an audible effect at the distant receiver and the second so changes the character of the waves that the sound in the distant receiver becomes more or less indistinct or inarticulate, consonant sounds are especially liable to become confused in this way.

W. S. F.

NOTES ON ENGINEERING.

'CHILLED' CAST IRON FORTS.

DOCUMENTS laid before the Board of Fortification and Ordnance of the United States Army, recently, contain some interesting information regarding the applicability of one of those materials which this country has always produced in highest perfection, in the construction of coast-defences. This country, alone, employs chilled cast iron to the exclusion, practically, of all other materials in car-wheel construction and certain brands of domestic irons possess a very extraordinary combination of strength, toughness, and capacity for taking on, by 'chilling,' a hardness exceeding that of tool-steel. Our ordnance cast irons, in earlier days, were of rare quality and our irons and steels generally are unexcelled.

For some years past, the Grusonwerk of Magdeburg-Buckau has been employing chilled cast iron in the construction of shields and turrets in the coast-defence systems of European countries, practically after the plan of the American inventor, Timby, of a half-century ago and of his licensee, John Ericsson, who used the device on the 'monitors.' The 'Endicott Board,' represented by Captain Bixby, U. S. A., investigated this matter, in 1865, with the result that the system was recommended and the erection of 22 such turrets was advised for defense of our principal harbors.

It was found that some forty turrets had been built for European governments and that probably many others, the location of which had been carefully concealed, were in existence. In the famous trial at Spezzia, an Italian turret was attacked by the shot of an Armstrong 100-ton, 16.93-inch, gun at 150 yards, the projectile weighing one ton, and withstood three such shots, each impact measuring 47,566 foot-tons. They have since been erected and accepted by a number of the European governments for defence of particularly important points. Germany has ten or a dozen.

In this country, notwithstanding our special advantage in quality of iron suited to this purpose, the general indifference of Congress and the people respecting coast-defence up to the outbreak of our recent war prevented any action being taken toward introduction of this later Timby turret, the Gruson chilled iron construction. In 1898, however, in the midst of the excitement and anxiety awakened by the rumors of a possible descent of the enemy upon our coasts, Mr. P. H. Griffin, of Buffalo, a well-known and expert manufacturer of chilled iron wheels, and other constructions, privately negotiated with the Krupps, who had by this time assumed control of the Gruson invention, and secured the right to build in this country and was given possession of the various special secret and expert methods which had made the Grusonwerk successful. A company was formed in the United States, and it is, as we are informed, now established in new works at Chester, Pennsylvania. This remarkable and important manufacture is thus finally brought into a country in which it is known that the finest material in the world is available for its purposes. *

The satisfactory chilling of cast iron to a depth of a fraction of an inch and on the surfaces of small masses, like car-wheels, has not been always found an easy matter; the production of the chill required for ordnance purposes on the surfaces of masses weighing from four to six millions of pounds involves, undoubtedly, some peculiar and difficult manipulations. Should it prove as successful, however, as with our car-wheels, another important addition will be made to the list of benefits conferred, by the metallurgical chemist and the foundryman together, upon our industrial system. This constitutes one of the most remarkable scientific achievements of the time.

THE 'AIR-SPLITTING TRAIN.'

THE daily press of recent dates has been supplied from Baltimore with interesting and impressive accounts of the repetition of the Bessemer experiment with what is now denominated the 'air-splitting train,' a train which is given, as far as practicable, the form of a cigar in its outer shape and which thus evades to some extent the head-resistance of the air and the friction of irregular surfaces on the side of the train and at its junctions between adjacent cars.

*See paper by Mr. T. Guilford Smith, 'Gruson Rotating Turret.' *Trans. Am. Inst. Min. Eng.*, Feb. 1900.

This plan was adopted by Sir Henry Bessemer, a half century ago, and with, as he thought, excellent results; but no one knows precisely to what extent the reduction of resistance occurs. The Bessemer train seems to have been a more perfect illustration of the principle of construction proposed than is the modern example.

A speed of 78 miles an hour is reported from Baltimore; but this is, of course, little to the purpose. The same weight of train could probably have been forced up to the same speed by a plucky engineer if constructed in the usual way. In fact, speeds of equal and greater magnitude are, and have for years been, made on the East and West Coast Railways of Great Britain and the record is held in our own country at above 100 miles an hour with the common form of train. What is wanted is an accurate comparison, by experts, of resistances at equal speeds of the ordinary train and of the same size and weight of train encased with the cigar-shaped shell devised by Bessemer. Obviously, the more perfectly the cylindrical spindle is approached in the exterior conformation of the train, the less will be the air-resistance. This, at high speeds now coming to be not unusual, will no doubt prove of real value if the improvement of Bessemer can be effected without too much loss of comfort, convenience and safety. Bessemer fitted his engine with a conoidal 'bow,' as the seaman would call it, and also coned the rear of the train, as well as providing against breaks between adjacent cars. The train was fairly cylindrical. He ran it at enormous speeds, for the time, until it was finally 'ditched.'

R. H. Thurston.

CURRENT NOTES ON PHYSIOGRAPHY.

TOPOGRAPHIC TERMS.

H. M. Wilson, of the U. S. Geological Survey, has compiled a very useful 'Dictionary of Topographic Forms' (*Bull. Amer. Geogr. Soc.*, xxxii, 1900, 32–41), containing definitions of some 260 words, and 'intended to include all those terms employed popularly or technically in the United States to designate the component parts of the surface of the earth.' Besides a majority of English words, there are many taken from Spanish and French, and a few from other languages, making an interesting and characteristic polyglot vocabulary that has naturally grown up in different parts of the country. The definitions are terse and appropriate in nearly all cases. Escarpment is very properly limited to 'an extended line of cliffs or bluffs,' instead of being allowed to include the body of an unsymmetrical ridge, as is the practice of some English writers. Interfluve is of relatively new coinage, equivalent to doab of northern India, meaning 'the upland separating two streams having approximately parallel course.' The printer seems to have suppressed a few words, such as 'the low alluvial land about,' at the beginning of the definition of delta which reads 'the mouth of a river which is divided down stream into several distributaries.' Bottom, as well as bottom land, should be defined according to its use in the Southern States, as a narrow flood plain. Cascade is not 'a short, rocky declivity in a stream bed,' but the dashing water on such a declivity. Upland might advisedly be used for surfaces intermediate in altitude between lowland and highland, instead of serving as a synonym for highland. Landslide deserves definition in the active sense of a sliding mass, as well as in the passive sense of a mass that has slid. Several words have a more general use than is indicated; for example, dome and meadow are well known in the east as well as in the west. Malpais is perhaps by accident referred to French instead of to Spanish origin.

It is to be hoped that geographers in different parts of the country may contribute supplements to this fundamental list, and that it may be republished in more extended form in a year or two. Adjectives and perhaps verbs also might then be added to the nouns that now appear alone. The following terms are offered for consideration, some being taken from Whitney's 'Names and Places' (1888):—Slough, towhead, ford, reach (used in Wilson's definitions, but not defined), meander, bend (perhaps kink also, from Alaska), narrows, shut-in (Mo.), dismal (N. C.), barrens (Tenn.), glen (N. Y.), intervale (N. H.), falls (in the Maryland sense of a cascading stream), river (in the Florida sense of a 'long-shore lagoon), banks (in the N. C. sense of a sand reef, and also in the fisherman's sense of fishing grounds on a shallow sea floor) whale-back and horseback (Me.). The list might be extended still further.

MORAINES OF SOUTH DAKOTA.

THE account of the 'Moraines of southeastern South Dakota and their attendant deposits' by Todd (U. S. Geol. Surv., Bull. 158, 1899) is another example of those remarkable correlations between glacial action and existing topography by which so much light has been thrown on modern physiographic study in recent years. The outer (Altamont) moraine marks the border of an irregularly lobate glacier lying between Missouri and Big Sioux rivers, whose advance was retarded where preglacial hills (outliers of Cretaceous and Tertiary strata) stood in its way; here the moraine rises in an interlobate upland which terminates inward (towards the glaciated area) in a strong cusp, as in Turtle and Turkey hills; the rim of the upland is incised by broad channels of glacial waters which flowed from the ice, and the axis of the upland is trenched by the trunk stream that resulted from the confluence of these ice-water branches. The broad lobate glacier seems to have invaded the preglacial course of the Missouri, which therefore rose as a lake (Old Red lake) just above the entrance of White river from the western plains; the lake level being recorded by a large delta built by this river. The outlet of the lake was along the southwestern margin of the ice where a new channel has been cut from the mouth of White river to that of Niobrara river. At a later stage, a second moraine (Gary) was formed around a reduced ice lobe, whose area is roughly marked by the space between the James and Vermillion rivers. The floor of the ice lobes is now a smoothly undulating plain of till or silt, free from buttes and incised by narrow stream channels.

BULLETIN OF THE AMERICAN BUREAU OF GEOGRAPHY.

E. M. LEHNERTS, of the State Normal School, Winona, Minn., with nine associate editors, has lately issued the first number of a quarterly bulletin with the above title, as an aid to the teaching of school geography. A report of a committee on lantern slides, illustrated with small prints of thirty views, is the most original feature of the issue, which is otherwise largely occupied with general articles on time-honored subjects. Four writers treat of the 'Educational value of geography,' 'What to teach in geography,' 'Geography as a basis for correlation' and 'Concrete geography.' Physiography has four articles by Collie, Tarr, Kümmel and Moore, containing some specific suggestions regarding equipment and some illustrative examples, along with generalities. An article on a special topic, the 'Points of the Compass,' is at fault in neglecting the sun's noon culmination as the simplest means of determining the local meridian and the cardinal points, and in asserting that "the north star is thus the only satisfactory, because the only fundamental starting point for determining direction." A committee on exchange of products, with Philip Emerson of Lynn, Mass., as chairman, promises to be a practical aid to isolated teachers.

W. M. DAVIS.

THE STUDY OF ELECTRICAL PRESSURE.

PROFESSOR JOHN TROWBRIDGE, of Harvard University, contributes the following account of his work on electricity to the *Harvard Graduate Magazine:*

The remarkable development of the practical employment of electrical phenomena has put physical laboratories at a certain disadvantage; for the electrical engineer and the assistants in the great electrical companies have it in their power to experiment with electrical currents of far greater strength than it is possible to obtain in a university laboratory. While the college professor might perhaps employ a hundred horse-power and its equivalent in electrical energy, the electrical engineer has at his command many thousand horse-power. He can study the effect of tremendous currents in breaking up chemical compounds and in forming new compounds. He can investigate the phenomena of electro-magnetism on a great scale. There is, however, one field in which the college professor can enter the electrical field on more than equal terms as regards practical resources with the electrical engineer. This field is that of great electro-motive force, and I, therefore, thinking that it is important at this stage of the development of electricity to take advantage of the many practical improvements in dynamos and electrical circuits for the furtherance of the study of electrical pressure, have had installed in the Laboratory the most powerful apparatus for this purpose in the world.

The plant consists of 20,000 storage cells giving 40,000 volts or electrical units of pressure; and this can be augmented to 3,000,000 volts. In the construction of this powerful plant it was found that this limit of 3,000,000 of volts could not be exceeded as long as the apparatus is situated in a building, for the inductive action of the walls and the floors is so great that a serious loss results. In order to obtain the full effect of 3,000,000 volts the apparatus should be placed in the center of Holmes field and should be raised at least thirty feet from the ground. This great electrical plant opens a wide field of scientific inquiry. It enables one to study by spectrum analysis the effect of intense heat on gases and the vapor of metals; for by means of this battery one can produce the highest degree of instantaneous temperature yet attained. I am at present investigating the spectrum of hydrogen in the hope of obtaining some clue to the conditions of temperature in the stars. The plant also furnishes the ideal method of producing the X-rays. A Crookes can be made to glow with perfectly steady light giving out the X-rays with intense brilliancy and affordstrong contrasts which have long been desired. For surgical purposes a steady source of these rays is of the utmost importance. All the methods in present use produce the rays by a more or less fluctuating process, whereas the method I have adopted is by the use of a steady current of electricity from a battery constantly in one direction. This current can be regulated to any desired degree. The result has never been accomplished before.

The interesting fact that a steady current at 40,000 units of pressure or volts is so efficient in producing the X-rays leads me to believe that a plant similar to the one in the Jefferson Physical Laboratory, but of much smaller dimensions—having the same number of cells but smaller ones—may be a desirable adjunct to a great hospital.

THE NEW YORK STATE COLLEGE OF FORESTRY.

The College of Forestry of Cornell University has made provision, as has been already stated in this Journal, for a course of lectures on 'Fish and Game Protection and Fish Culture' as a regular part of the curriculum, and Dr. Barton W. Evermann, Ichthyologist of the U. S. Fish Commission, has been selected as special lecturer to give the course. The instruction will consist of laboratory work and field excursions, together with lectures upon the life-histories of food and game fishes, their artificial propagation and protection; the relation of the forests to the streams and lakes and their inhabitants; the proper care of streams and lakes with reference to forestry, logging, lumbering, milling, mining and irrigation operations; and the value and protection of the mammals and birds of the forest.

Dr. B. E. Fernow, the Director of College of Forestry, properly considers that the forester should know not only how to care for the forest proper, but that he should understand that the protection of the denizens of the forest and the streams and lakes within the forest, and their inhabitants, also, constitute a legitimate and important part of his work.

The graduates of the College of Forestry are the men who will be called to the management of the National Forest reservations and the large private forest properties, and it is gratifying to know that they will enter upon their work with the broad and rational view of their duties and their opportunities.

This course was first given to the juniors and seniors of the present year at Axton, N. Y. (where the State College Forest is located) during the second and third weeks in May. Hereafter the course will be considerably lengthened in time and made more comprehensive in character.

Dr. Fernow will receive the thanks and congratulations of all persons interested in the preservation of our forests and the protection of the inhabitants of the forest and the forest waters for the successful inauguration of this interesting and important phase of forestry instruction.

The value of the extensive timber investigations planned and carried on by Dr. Fernow, when Chief of the Division of Forestry, U. S. Department of Agriculture, is more and more appreciated by practitioners and investigators, as the results become better known. One of the important results was the discovery of the relation between the strength of a beam and of a column of the same material, which was deduced and mathematically developed by F. E. Neely, C.E., from the many thousand tests made on comparable material during the extended general test series.

This winter, Professor C. A. Martin and Mr. George Young, Jr., both of the College of Architecture, Cornell University, have, under the auspices of Professor F. Roth, of the New York State College of Forestry, in connection with the course on Timber physics, carried on a series of tests, published in *Engineering News*, that furnish experimental proof of the correctness of this relation, which is that the strength of a beam at the elastic limit is equal to the strength of the material in endwise compression.

In other words, if we wish to know what load a beam will carry without injury to its elastic properties, we only need to test the material in compression to failure; the load which accomplishes the failure is also the extreme load for a beam strained to the elastic limit.

The practical value of this discovery is readily seen: A simple test in compression gives, without the introduction of difficult formulæ, immediate answer to the practically important question of the beam strength to safe limits.

The tests also remove any doubt as to whether wood possesses a definite elastic limit, which, although less pronounced than in metals, is, nevertheless, readily recognized.

THE FORTHCOMING MEETING OF THE BRITISH ASSOCIATION.

THE issue of *Nature* for June 14th contains an article by Mr. Ramsden Bacchus giving an account of the plans for the Bradford meeting of the British Association from which we take the following particulars:

The meeting promises to be an unusually large and important one. Bradford being midway between London and Edinburgh, serves as a common meeting ground for scientific men from the south of England and from Scotland and Ireland, and it is within easy reach of the Midland and Northern University Colleges. Bradford and Leeds are so close together that for such a purpose as this they are almost one city, and the Bradford Committee, therefore, have the advantage of the Yorkshire College being practically on the spot. The last meeting of the British Association in Bradford was held in 1873, but since that time the city (which, by the way, was then only a town) has practically been rebuilt, and has grown and developed in a manner resembling the progress of an American rather than that of an English town.

It is probable that the number of visitors will be far above the average; already some sixty or seventy Fellows of the Royal Society have announced their intention of being present, and professors and eminent lecturers from nearly every university in England, Scotland and Ireland have promised to attend. The Church will be represented by the bishop of Ripon, the legal profession by the Master of the Rolls and Lord McLaren, and the names of over a score of members of both Houses of Parliament have been sent in.

The meeting will commence on Wednesday, September 5th, when the new President, Professor Sir Wm. Turner, of Edinburgh, will deliver his address in St. George's Hall. On the following evening the Mayor of Bradford will give a conversazione in St. George's Hall, at which it is hoped there will be exhibits illustrating the most recent scientific work. On Friday evening the lecture will be delivered in St. George's Hall by Professor Gotch, F.R.S., on 'Animal Electricity.' The lecture to artisans on Saturday will be given by Professor Silvanus Thompson, F.R.S., and it is expected that there will be an audience in St. George's Hall of 4000 to 5000 working men. On Monday afternoon the Mayor and Corporation will give a garden-party in Lister Park, and in the evening an address will be given by Professor W. Stroud on 'Range-Finders.' The Mayor and Corporation will give another large conversazione on Tuesday evening, and on the Wednesday evening a concert will take place in St. George's Hall with the Permanent Orchestra and the Festival Choral Society, under the conductorship of Mr. Fredk. Cowan.

During the week there will be a textile exhibition at the Technical College, which will illustrate the various processes of the local industries, and the machinery employed can be seen in motion. There will be a reception at the College on Thursday afternoon, September 6th, and the smoking concert in honor of the President will also be given at the Technical College, after Professor Gotch's lecture on Friday.

Excursions to places of interest in the neighborhood will be made on Saturday, the 8th, and on Thursday, the 13th; among the places selected are Bolton Priory, Ripon and Fountains Abbey, Malham, Clapham and Ingleton, the Nidd Valley, Farnley Hall, Haworth, Ilkley, Knaresboro' and Harrogate. In addition to a number of smaller guides to the places to which excursions are to be made, the usual guide book will be provided by the Publications Committee. This book will be divided mainly into three sections. The first will deal with the history of Bradford and the development of the Bradford trade, the second section with the Bradford industries and institutions, and the third part, which is under the sectional editorship of Mr. J. E. Wilson, will deal with the scientific material of the locality, the flora, fauna, geology, meteorology, climate and public health. There will be in addition a number of pages devoted to the topography of the district, for which Mr. J. H. Hastings is responsible.

SCIENTIFIC NOTES AND NEWS.

On June 12th and 13th the delegates to the conference on the International Catalogue of Scientific Literature met in the rooms of the Royal Society, London.

The American Academy of Arts and Sciences has elected Sir Archibald Geikie, F.R.S., an honorary foreign member in the place of the late Carl Friedrich Rammelsberg.

Professor Charles F. Chandler, of Columbia University, and Professor J. Mark Baldwin, of Princeton University, have been given by Oxford University its newly created D.Sc. degree.

The degree of doctor of engineering has been conferred on Mr. J. Elfreth Watkins, of the U. S. National Museum, by the Stevens Institute of Technology, in recognition of his long and valuable studies in the history of the development of railroad engineering in the United States.

At the last meeting of the Royal Society of Edinburgh, according to *Nature*, the following were elected as British Honorary Fellows: Dr. Edward Caird, master of Balliol College, Oxford; Dr. David Ferrier, professor of neuropathology, King's College, London; Dr. G. F. Fitzgerald, professor of natural and experimental philosophy, Trinity College, Dublin; Dr. Andrew Russell Forsyth, Sadlerian professor of pure mathematics in the University of Cambridge; Dr. Archibald Liversidge, professor of chemistry in the University of Sydney; Dr. T. E. Thorpe, principal of the Government Laboratories, London; and, as Foreign Honorary Fellows: Dr. Arthur Auwers, secretary, Royal Prussian Academy of Sciences; Professor Wilhelm His, Leipzig; and Professor Adolf Ritter von Baeyer, Munich.

Dr. S. Gabriel has been appointed assistant director in the newly built chemical laboratory of the University of Berlin.

The managers of the Royal Institution, London, on the occasion of the retirement from office of the honorary secretary, passed a unanimous resolution to place on permanent record an expression of their high appreciation of the admirable way in which he has performed the duties of that office, and of his signal services to the Institution generally.

The formal opening by Lord Lister of the new clinical laboratories at the Westminister Hospital took place on June 12th. Among those present were Sir John Wolfe Barry, Chairman of the House Committee, Lord Kelvin, Dr. Church, the President of the Royal College of

Physicians, Sir William MacCormac, the President of the Royal College of Surgeons; Sir John Burdon Sanderson, Bart., Sir Michael Foster, K.C.B., M.P., and Sir Joseph Fayrer, Bart, K.C.S.I.

WE learn from the Philadelphia *Medical Journal* that Dr. W. W. Keen has raised a $50,000 library fund for the College of Physicians of that city.

MR. J. S. BUDGETT has been awarded a grant of £50 from the Balfour Fund of Cambridge University to aid him in his zoological researches.

PROFESSOR W. B. CLARK, of the Johns Hopkins University has been appointed by the Governor of Maryland, Commissioner on behalf of the State of Maryland to act with a similar Commissioner on behalf of the State of Pennsylvania and the Superintendent of the U. S. Coast and Geodetic Survey in the reëstablishment of the old historic Mason and Dixon line, in part forming the boundary between Maryland and Pennsylvania. This famous line, so long regarded as the boundary between the north and south was run by two English surveyors, Mason and Dixon, between the years 1764–68, and was marked throughout its eastern portion by granite monuments brought from England that had cut on their southern faces the arms of Lord Baltimore and on the northern the arms of the Penns. It was by far the most extensive engineering work of colonial days. The old line is now very obscure because of the destruction of many of the monuments and property interests are suffering as the result. It is the purpose of the new Survey to redetermine and properly remark the old line.

THE Director of the United States Geological Survey, says the New Haven correspondent of the New York *Evening Post*, has placed Professor H. S. Williams, of Yale University, in charge of the mapping, areal geology and preparation of the geological folios of the middle section of Connecticut, including the topographical sheets of Granby, Hartford, Meriden, Middletown, New Haven, and Guilford. Those west of the seventy-third meridian are already under way, in charge of Professor Hobbs, of Wisconsin University. Dr. H. E. Gregory, assistant to Professor Williams, has done the field work on the crystalline rocks of the Granby and Middletown sheets, and will work during the summer on the crystallines of the Meriden sheet, and the triassic areas of the Connecticut valley in general. The triassic and crystalline work will probably be finished this year. The region to be covered is an exceedingly interesting one in this State, with its volcanic remnants, dikes, terraces, pot-holes and glacial boulders, and moraines in the area already partly covered by the investigations of Dana.

AFTER thirty-seven years' service as secretary to the Paleontographical Society (London) the Rev. Thos. Wittshire has retired from that office. The present position of this Society is mainly due to the influence of Mr. Wittshire, as was recognized some time ago by those of his admirers and others who presented him with a testimonial in the form of his own portrait in oils. The council has requested Dr. A. Smith Woodward, of the British Museum, to join the Society for the purpose of taking over the secretarial and editorial duties. It is no doubt hoped that Dr. Smith Woodward's eminence as a paleontologist and experience as a writer will attract to the Society the numerous British paleontologists who have hitherto manifested their interest in its good work by criticism unaccompanied by subscriptions. He will have no easy task to please all critics: those who stigmatize as 'paving-stone paleontology' the descriptions of local faunas by enthusiasts who are anything but zoological specialists; and those whose lack of patience (or other quality) does not permit them to master the elaborate zoological investigations of restricted groups of fossils, and whose love of ease sets them in opposition to new conceptions and the new language in which they are perforce expressed.

Nature states that the president of the British Board of Education has approved of a committee, which is now sitting, "to inquire into the organization and staff of the Geological Survey and Museum of Practical Geology; to report on the progress of the Survey since 1881; to suggest the changes in staff and arrangements necessary for bringing the Survey in its more general features to a speedy and satisfactory termination, having regard especially to its economic importance; and, further, to report on the desirability, or otherwise, of transferring the Survey to another public department." The members of the committee are: The Right Hon. J. L. Wharton, M.P. (chairman), Mr. Stephen E. Spring Rice, C.B., Mr. T. H. Elliott, C.B., General Festing, C.B., Dr. H. F. Parsons, Mr. W. T. Blanford, F.R.S., and Professor C. Lapworth, F.R.S., with Mr. A. E. Cooper as secretary.

At a meeting of the Board of University Studies of the Johns Hopkins University held May 23, 1900, the following minute in regard to the death of Professor Thomas Craig was unanimously adopted:

"The members of the Board of University Studies of the Johns Hopkins University desire to express their sorrow at the death of their friend and colleague, Professor Thomas Craig, who, as student and teacher of mathematics, had been connected with the University for nearly the entire period of its existence. One of the brilliant young men whom Professor Sylvester attracted to the University in its early days he won straightway the favorable notice of that eminent man for the enthusiasm and intellectual acumen with which he entered upon the study of advanced mathematics, then almost an unknown science in this country; and this fortunate combination of interest, energy, and ability characterized his entire career. At the time of his death he was occupied in the preparation of a treatise on the Theory of Surfaces. Undoubtedly the intense ardor with which he engaged in this work contributed in large measure to that impairment of the nervous system from which he had recently suffered. Professor Craig possessed great power of research, and wrote much for various mathematical journals. For many years he was editor of the *American Journal of Mathematics*, and it is largely due to his zeal and able direction that that Journal continues to hold its high rank in the mathematical world. Professor Craig occupied a place in the very front rank of American mathematicians. His scientific ideals were the highest, and as teacher, editor, and investigator, he brought to his work a high degree of originality, and an intellectual ardor which was a source of inspiration to all with whom he was closely associated."

Walter Percy Sladen, formerly zoological secretary of the Linnean Society of London, died at Florence on June 11th. Mr. Sladen wrote the Report on the Asteroida dredged by the *Challenger*, and numerous papers on recent fossil Echinoderms. A monograph by him on the British Cretaceous Asteroidea was in course of publication by the Paleontographical Society. Some years ago Mr. Sladen had an attack of the so-called influenza, and the effects of that combined with the cares of an estate to which he recently succeeded, checked his activity as a zoologist. One of his last pieces of work was the revision of the sections on star fish, and sea urchins in Dr. Eastman's edition of Zittel's 'Paleontology.' His British colleagues will miss not only a leader in a difficult branch of zoology, but a genial personality.

We regret also to record the death of Professor Mortiz Löw, Chief of Division in the Geodetic Institute of Potsdam and of Dr. Julius Althaus the well known physician and neurologist.

We learn from *Nature* that a meeting was held at the Meteorological Society on May 31st to consider the question of a memorial of the late Mr. G. J. Symons, F.R.S. It was resolved that the memorial should take the form of a gold medal, to be awarded from time to time by the Council of the Royal Meteorological Society for distinguished work in connection with meteorological science. An executive committee was appointed to take the necessary steps to raise a fund for this purpose. Contributions will be received by the Assistant Secretary, Mr. W. Marriott.

Dr. Donaldson Smith has returned to London from his journey across the unexplored tract of country between Lake Rudolph and the White Nile. The London correspondent of the New York *Evening Post* states that he was the first white man to reach the river, approaching it from the Somali coast, and travelling almost due west. He started on the 1st of August, 1899, and reached Fort Berkeley, near Lado, on the 17th of March, 1900. Dr. Smith says that he came through almost entirely unmolested by natives; had no occasion to fire a shot in self-defence, and lost only two men out of the small force of eighteen Goorkhas who formed his escort, this being the first time ex-soldiers of the Indian army have accompanied an expedition of this character. On reaching the Nile, Smith sent his men with Mr. Fraser, the naturalist, home by way of Uganda and Mombasa, while he himself stayed at the fort for six weeks, and returned with Major Peake's expedition, by way of Khartum to Cairo. In addition to important geographical observations Dr. Smith obtained a large and valuable collection of specimens of the fauna of Central Africa.

THE second meeting of the Latin-American Scientific Congress will be held at Montevideo from March 20th to March 31st, 1901. The work of the Congress will be divided among nine sections.

THE annual meeting of the Italian Botanical Society will be held at Venice on September 9th–15th, under the presidency of Sig. Sommier.

IN view of the great importance of the scientific publications of Messrs. D. Appleton & Co. we are glad to learn that plans for the reorganization of the company and for the continuance of the business have been announced by the reorganization committee, of which James G. Cameron, vice-president of the Fourth National Bank, is chairman. The valuation of the assets is placed at $3,224,787.18. The liabilities are $1,346,696.78. The plan of reorganization provides for the unifying of the title and ownership of the three business establishments into the new corporation of D. Appleton & Co. The capitalization of the new company will be negotiable gold notes, six per cent. for $1,400,000, syndicate notes for $250,000, and capital stock, $3,000,000. General creditors are to be paid 25 per cent. in cash, and 75 per cent. in the six per cent. negotiable mortgage gold notes. The preferred obligations, such as taxes, wages, interest on mortgage, royalties, etc., amounting to $176,698.78, are to be paid in full. A cash working capital of $250,000 is to be provided. It is said that Mr. William H. Appleton will be made president of the new company and Mr. James G. Cameron chairman of the board of directors.

MR. P. STRICKLAND, United States Consul, writes from Gorée Dakar, under date of May 1st, that an exposition has just been held at Dakar which was of interest, as it was probably the first of its kind in the colony, if not in intertropical Africa. The exposition was opened with ceremonies and speeches appropriate for the occasion on the 15th of March, and closed on the 14th of April. There were exhibited, among other things, the animals of the country, including ostriches; specimens of rubber, gums, nuts, and most of the other products; fish and native gear for catching it; native jewelry, some of which is very fine; hides and skins, including bird skins for mounting on hats; furniture made in the country; native woods, etc. All the objects were artistically displayed in the beautiful park at Dakar, and, in order to encourage the natives to visit it, no entrance fee was charged. The exposition was very successful. It may be noted that the government is doing everything to encourage agriculture in the colony, and has imported seeds from the rubber trees of Brazil for free distribution among those willing to plant them.

UNIVERSITY AND EDUCATIONAL NEWS.

PRESIDENT FAUNCE announced at the commencement of Brown University that the amount needed to complete the million dollar endowment fund had been subscribed. The gifts received during the week immediately preceding commencement include one of $50,000 from Mr. Frank A. Sayles, of Pawtucket, as a memorial to his mother and sister, and $25,000 from Marsden J. Perry, of Providence. Numerous smaller sums were also received, bringing the total amount up to the sum of $1,096,106.

THE reversionary interest of Harvard University, Williams College and the Public Library at Springfield, Mass., in the estate of David A. Wells will amount to about $70,000 each.

AT the commencement of Mt. Holyoke College, it was announced that the amount collected for the second endowment fund had already reached the sum of $75,000 of which $50,000 is contributed by Dr. D. K. Pearson, of Chicago. A letter was received from Mr. John Dwight, of New York, offering to give $60,000 for a memorial building to be built on the site of the old Dwight House. Twenty-five thousand dollars of the endowment fund has been devoted to the establishment of a chair of psychology.

The following gifts and bequests have also been announced during the past week: Edgar C. Brackett, a member of the State Senate of New York, has given $30,000 to Cornell College, Mt. Vernon, Ia. By the will of Alexander H. McFadden, who died recently in Philadelphia, Dickinson College, Carlisle, Pa., receives $10,-000. At the commencement of Smith College President Seelye announced that $32,000 had been given to the College from various sources. Ezra J. Warner, of Chicago, has added $20,000 to a previous gift of $50,000 for a science hall for Middlebury (Vt.) College.

Professor Charles A Young, of Princeton University, delivered the commencement address before Adelbert College. His topic was 'The Unities of Time, Space, Law and Substance in the Domain of Astronomy.'

The Board of Regents of the University of West Virginia has refused to accept the resignation of President Raymond and has passed a resolution approving the policy he has pursued in regard to the faculty and the students.

Dr. Henry Wade Rogers has resigned the presidency of Northwestern University.

At Smith College, Dr. Arthur H. Pierce, of Amherst, has been appointed associate professor in mental and moral science, and Ralph Barton Perry instructor in ethics and pedagogy. The following assistants have also been appointed: Miss A. Bruere in physics, Miss F. C. Smith in botany and Miss A. P. Hazen in zoology.

The following appointments to the position of instructor have been made recently: Dr. Lawrence E. Griffin, in biology and zoology, at Adelbert College; F. W. Kaffer, in civil engineering, at Princeton University; Dr. Walter B. Cannon, in physiology, in the Harvard Medical School; C. L. Bonton, in mathematics, and Mr. E. W. Morse, in natural history, in Harvard University.

The following degrees were conferred at the commencement of Cornell University: There were fifty-three who received A.B., forty who received Ph.B., and sixty-two who received B.S. This is the last occasion on which the two latter degrees will be conferred by the university. There were fifty-two LL.B.'s conferred, and six M.D.'s were added to the fifty-three already conferred at the Medical commencement in New York. Eight took B.S.A. (agriculture), seven D.V.M. (veterinary medicine), one (the first to receive such a degree in this country); B.S.F. (forestry), B.Arch. (architecture) was granted to ten candidates; C.E. (civil engineering) to fifty-two, and M.E. (mechanical engineering) to 100 of whom forty-three had specialized in electrical engineering. Fourteen were then given the degree of A.M., one of M.C.E., four of M.M.E. There were nineteen candidates for the Ph.D. degree of which thirteen were in the sciences as follows: William Chandler Bagley (psychology), Charles Edward Brewer (chemistry), Kary Cadmus Davis (botany), Stevenson Whitcomb Fletcher (horticulture), Charles Tobias Knipp (physics), Gertrude Sharb Martin (social science), William Fairfield Mercer (entomology), Wilhelm Miller (horticulture), Vida Frank Moore (ethics), Edward Charles Murphy (civil engineering), William Alphonso Murrill (botany), Guy Montrose Whipple (psychology), and Ambrose Paré Winston (political science).

At Cambrige University Mr. L. R. Wilberforce has been appointed university lecturer in in physics; Mr. G. F. C. Searle a university lecturer in experimental physics, and Dr. G. H. F. Nuttall university lecturer in bacteriology and preventive medicine.

The sixteen wranglers of the Cambridge Mathematical Tripos this year are headed, says *Nature*, by Mr. J. E. Wright of Trinity, Mr. A. C. W. Aldis of Trinity Hall being second wrangler. An Indian student, Mr. Balak Ram of St. John's is fourth; and Miss W. M. Hudson of Newnham College, sister of the senior wrangler of 1898, is bracketed eighth wrangler. Miss E. Greene, also of Newnham, is equal to tenth. St. John's claims five of the wranglers, Trinity four, Clare two. In Part II., the bracketed senior wranglers of last year, Mr. Birtwistle of Pembroke, and Mr. Paranjpye of St. John's, are placed with two others in the first division of the first class.

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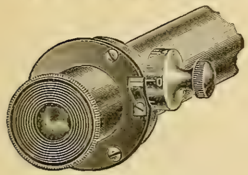

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